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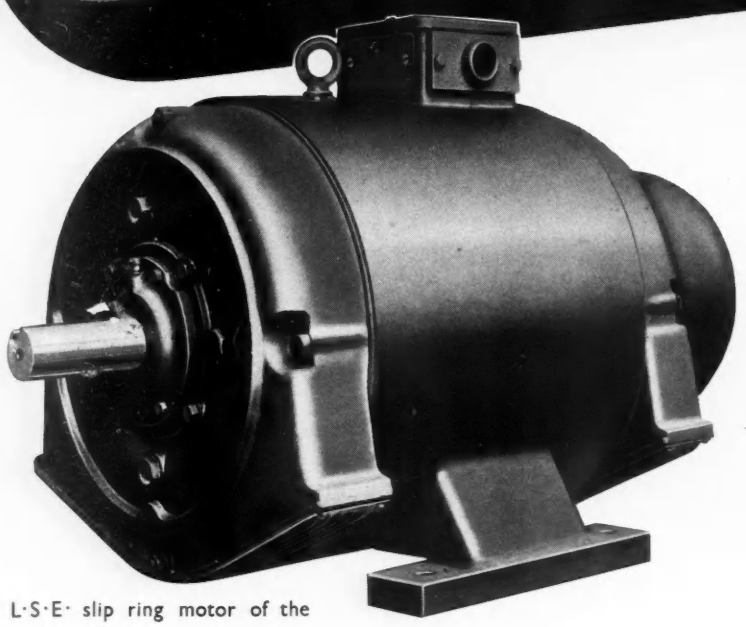

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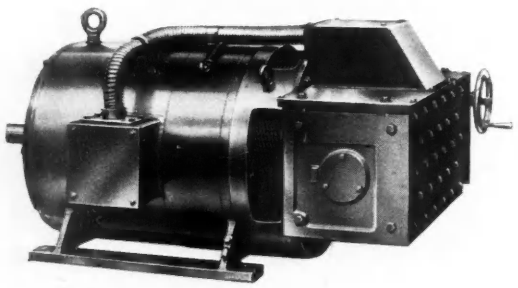

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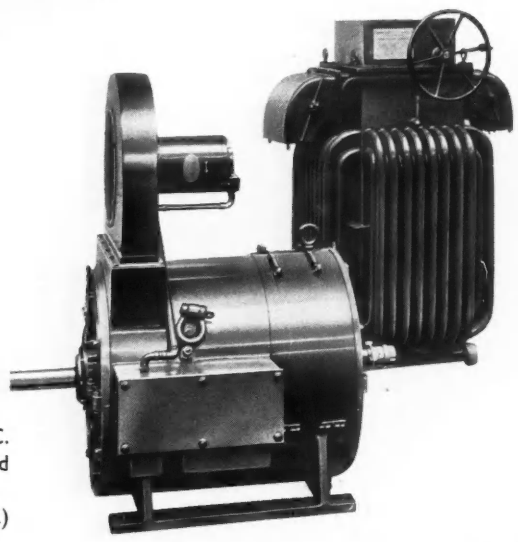

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THE ENGINEER

A Seven-Day Journal

The "Thetis" Enquiry

ON Monday, July 3rd, the first sitting of the Tribunal which has been specially appointed by the Government to inquire into the loss of the submarine "Thetis" was held at the Law Courts, London, under the presidency of Mr. Justice Bucknill. The assessors, we may recall, are Captain G. C. P. Menzies, a submarine expert; Captain A. H. Ryley, one of the Elder Brethren of Trinity House; and Professor T. B. Abell, Professor of Naval Architecture at Liverpool University. Almost the whole of the first day was occupied by the opening statement of the Attorney-General, Sir Donald Somervell, who dealt with all that happened from the time the "Thetis" left the harbour till she started her diving trials in Liverpool Bay. He described how she struck the bottom, and the efforts which were made to bring her stern to the surface. The working of the locking gear used to secure the rear door of the torpedo tubes was demonstrated by a model. Sir Donald paid a warm tribute to the morale and heroism of those who lost their lives. Further evidence was then given by Captain Oram, one of the four survivors who escaped by the Davis apparatus, who said that those on board showed a quiet bravery which as a memory would live with him for ever. Captain Oram referred in his evidence to the doubt in the minds of those controlling the submarine of the correctness of the statement on the "trim-chit" that all the torpedo tubes were full. He went on to describe the efforts made to check this, and the inrush of water to the torpedo compartment which followed. He then detailed the plan of escape and the brave efforts made to close the rear door of No. 5 tube. On Tuesday evidence was given by Lieut. Woods, another survivor, who fully corroborated the evidence given by Captain Oram. He dealt with the steps he took to test No. 5 tube and the inbreak of water, and the later unavailing efforts he made to close the door. He described the steadily worsening of the air conditions within the submarine, and the increasing lassitude, which possibly prevented more use of the Davis escape apparatus being made. In the course of the inquiry Mr. Justice Bucknill said that it had been already established that the slowness of the rescue ships in arriving at the site had contributed to the failure to save the lives of the crew.

Lee-on-Solent Naval Air Station

ON Thursday, June 29th, we were present at a Press inspection of the Royal Naval Air Station at Lee-on-Solent, which the Navy took over from the Royal Air Force a few weeks ago. This station, in addition to serving as the headquarters of the Fleet Air Arm, is also an equipment, storage, and manning depot for specialist ratings and incorporates No. 2 Observers' School. Here the machines from the various ships undergoing refit or remaining in harbour for long are stored, overhauled, and repaired. An extensive and well-equipped workshop is continually busy on routine overhauls and repairs on both the machines used at the station and those serving with the Fleet. At present the observers' school is working at high pressure on the instruction of fifty officers, including naval officers specialising in air work, sub-lieutenants and midshipmen of the new (A) Branch of the Navy, and midshipmen of the R.N.V.R. The latter, after serving for a short period on board a warship, do short courses in tactics, signals, and gunnery, before entering the observers' school. Here they are given the necessary training in the air, in navigational and signal duties, in the "Shark II" land machines, "Walrus" amphibians, and "Seafox" floatplanes attached to the station. The station is particularly well suited for training purposes, as it has an excellent landing field at the back, in addition to a slipway running down to the Solent.

Railway Extensions in North London

As the result of co-operation between the London and North-Eastern Railway and the London Passenger Transport Board, regular traffic between the West End and East Finchley began on Monday morning, July 3rd. The through service to East Finchley has been made possible by extending the Board's northern line beyond Archway (Highgate) and by connecting it with the L.N.E.R. tracks at East Finchley. New tube tunnels, 2 miles long, follow the line of Archway Road, and pass under the L.N.E.R. Highgate Station, where a new tube station, with escalator interchange facilities, is being built, to a point just south of the L.N.E.R. East Finchley Station, where the new lines come to the surface on either side of the L.N.E.R. tracks, which run from King's Cross, *viâ* Finsbury Park to High Barnet and Edgware. The through service described is the first instalment of a large scheme undertaken jointly by the London and North-Eastern Railway Company and London Transport for the electrification of the L.N.E.R. lines to Alexandra Palace, High Barnet, and Edgware (12 miles), and their connection with the Underground Railway system of London Transport. It also includes the building of a new railway to extend London Transport's northern line from Edgware to Bushey Heath, a distance of 2½ miles. The extension opened to the public on Monday last is the first to be established as a result of the comprehensive programme for improvement of passenger transport facilities in London, undertaken jointly by London Transport and the main line railway companies in 1935. Although popularly described as the £40,000,000 scheme, in consequence of the increased prices of materials, the total cost is likely to be nearer £45,000,000.

Engineering Education and Training

THE Institution of Civil Engineers announces that a Conference on Engineering Education and Training will be held at the Institution from February 6th to 8th, 1940. Sir Clement D. M. Hindley, now President-Elect of the Institution, will preside over the Conference, and invitations to act as Vice-Presidents have been accepted by several eminent men. The Conference is being organised by a General Committee representative of engineering institutions, universities, technical schools and colleges, engineering consultants, industrial organisations, Government Departments, and other interests. The education and training of engineers has, since the time of Telford, been an essential interest of the Institution. Conferences and technical inquiries have been held, and reports issued, from time to time in connection with engineering education and training, but it is now nearly thirty years since a similar conference (held at the Institution in 1911) was convened. Having regard to the development of scientific knowledge and the extension of the field of practical engineering, together with the growth of educational facilities, during the past quarter of a century, it is hoped that valuable results will ensue from the forthcoming meetings. It is proposed to publish a number of papers, to be circulated in advance, which will form the basis of discussion at the sessions. Inquiries should be addressed to the Secretary, Institution of Civil Engineers, Great George Street, London, S.W.1.

The Employment Returns

IT is provisionally estimated that at June 12th, 1939, the number of insured persons, aged 16–64, in employment in Great Britain was approximately 12,810,000. This was 143,000 more than the total for May 15th, 1939. It is estimated that on a comparable basis there was an increase of approximately 600,000 as compared with June 13th, 1938. The improvement in employment between May 15th and June 12th extended to all but a few industries. It was most marked in building and public works contracting, agriculture and horticulture, hotel and boarding house service, the distributive trades, engineering, metal goods manufacture, the cotton wool, hosiery, printing, and fishing industries, and the road transport, dock, and harbour, and shipping services. On the other hand, there was a slight decline in employment in the coal-mining industry. At June 12th, 1939, the numbers of unemployed persons on the registers of employment exchanges in Great Britain were 1,098,793 wholly unemployed, 195,625 temporarily stopped, and 55,161 normally in casual employment, making a total of 1,349,579. This was 142,703 less than the number on the registers at May 15th, 1939, and 453,333 less than at June 13th, 1938. The total on June 12th, 1939, comprised 1,022,790 men, 28,264 boys, 266,836 women, and 31,689 girls. The total of 1,349,579 registered unemployed included 1,231,559 persons who were applying for benefit or unemployment allowances. An analysis of these applicants according to the length of the last spell of registered unemployment is given as 268,000, or 22 per cent., twelve months or more; 809,000, or 66 per cent., less than six months; 665,000, or 54 per cent., less than three months; 521,000, or 42 per cent., less than six weeks. During the four weeks ended June 19th, 1939, the number of vacant situations notified by employers to the employment exchanges and juvenile employment bureaux was 264,304, while the number filled was 224,803. Between June 21st, 1938, and June 19th, 1939, 2,886,018 vacant situations were filled, while in the period June 22nd, 1937, to June 20th, 1938, the number filled was 2,560,050.

The Southern Railway Electrified Extension

SPEAKING at a luncheon held at the Ch[illegible]am Town Hall on the occasion of the official opening of the Southern Railway's electrified lines to Maidstone West, Strood, Rochester, Chatham, and Gillingham, on Friday, June 30th, the Minister of Transport, the Right Hon. Euan Wallace, said that the completion of the section gave the company 770 route miles of electrified line. The rapid acceleration and easier and quicker terminal service which electric traction made possible substantially increased the effective capacity and earning power of both lines and rolling stock, and that was particularly important in dealing with the suburban railway problem of peak hour traffic. The electrification of the Southern Railway suburban system was one of those examples of co-operation between private enterprise and the State which had become fairly common since the war, and seemed likely to multiply in the future. Money for the scheme was raised with the assistance of a Government guarantee, and for that reason he might perhaps take some avuncular pride in the present ceremony. Official interest of the Minister of Transport in the railways of this country was primarily directed, first of all, towards safety, and, secondly, towards their adequacy in playing their part in an ordered transport system for the nation as a whole. From the point of view of safety, our railways had a record which set a standard for the rest of the world. Passengers killed in train accidents numbered one to every 156 millions carried, and even taking fatalities for all movement on rail, the figure was less than one per 1,000,000 train miles. He was glad to see that the road and rail interests did not propose to wait for an Act of Parliament in order to set about the task of substituting intelligent co-operation for cut-throat competition. A road-rail conference was already engaged in considering the possibility of a common classification of goods for both road and rail rates, and the adoption of uniform conditions of carriage.

A New Belfast Industry

FOLLOWING successful negotiations between London and Belfast firms, the Government of Northern Ireland announces that a new industry is about to be established on the site of the old North Yard of the Workman and Clark shipyard, which, after the closing down of Workman, Clark (1928), Ltd., in 1935, was acquired by National Shipbuilding Securities, Ltd. By arrangement with T. C. Jones and Co., Ltd., of Wood Lane, London, and two Belfast undertakings—George Cohen, Sons and Co., Ltd., steel and machinery merchants, and Chapman and Co., Ltd., structural engineers—a new factory is to be established for the manufacture of steel mesh reinforcement fabric, which is used for road-making and the strengthening of floors. The industry will occupy part of the old North Yard, which saw the birth of many famous ships, including the Orient liners "Orvieto" and "Otranto," and the "Victorian," one of the first ocean-going turbine-driven ships. All the steel which will be required for the new industry will, it is announced, be of British manufacture. The fabric which is now made in other parts of the United Kingdom has been extensively employed on Government and municipal contracts. The building in which the industry is to make its beginning has been leased by the Belfast Harbour Board, and so far as possible the skilled and unskilled labour which will be required will be recruited from Northern Ireland.

Stress Conditions in a High Multiple-Arch Dam

By IVAN E. HOUK*

No. I

ANALYSES of stress conditions in the multiple-arch sections of Bartlett dam, a 288ft. reinforced concrete dam recently constructed on Verde River, about 50 miles north-east of Phœnix, Arizona, developed some pertinent information which should be considered in designing high multiple-arch dams. For instance, the adoption of a buttress design which permits some rotation at the abutments of the arch elements was found to decrease abutment intrados stresses as much as 20 per cent. Accurate analyses by elastic arch formulæ showed that concrete weight loads cause appreciable tension stresses at the intrados at both crown and abutment sections. Earthquake shocks, assumed to occur during either empty or full conditions of the reservoir, were found to increase maximum stresses from about 9 to 39 per cent., the more important effects occurring at locations in the upper arches.

In designing multiple-arch barrels, engineers usually have considered maximum compressive stresses to occur during full reservoir conditions, combined with maximum temperature loads, and maximum tensile stresses to occur during empty reservoir conditions combined with maximum temperature loads. The results of the Bartlett dam studies showed that these considerations are sufficient for determining maximum compressive stresses at intrados and extrados locations and maximum tensile stresses at intrados locations; but not for determining maximum tensile stresses at extrados locations. Accurate analyses for variable reservoir loads showed that additional tension stresses may occur at extrados locations and that additional reinforcing steel may be needed at the upstream face of multiple-arch barrels, to carry these additional tension stresses which may occur at all elevations during different stages of increasing and decreasing storage. Beam action, which heretofore has not been analysed in designing multiple-arch dams, was found to reduce the additional tensile stresses caused by variable reservoir loads, also to reduce the compressive stresses occurring at such times. A trial load analysis for a partly filled reservoir showed that beam action may transfer appreciable portions of the water load to the longitudinal elements of the barrel and to the arch elements above the reservoir surface, reducing water load tensions as much as 24·5 per cent. at the abutments and 42·5 per cent. at the crown, and changing barrel stresses as much as 26 per cent. However, studies of wave action showed that beneficial beam effects at abutment extrados locations may be offset by the increased water loads which waves tend to produce at the abutments.

The following discussions are confined to load and stress conditions in the multiple-arch barrels. Buttress designs are not discussed, except to such extents as may be required in considering arch action. All arch analyses were made for inclined elements; that is, for arches in planes at right angles to the upstream slopes of the buttresses. All stress data included in this article are for plain concrete arches. Reinforcing was provided to carry tension forces at both intrados and extrados locations and steel stresses were carefully analysed, but since the analyses showed no unusual characteristics the results are not discussed herein. Effects of shrinkage and water soaking of concrete were assumed to be adequately provided for in the allowances made for maximum temperature changes.

Unless otherwise noted, arch stresses given in the following paragraphs were computed on the basis of yielding abutments. Effects of including abutment yielding are discussed under a special heading. All arch analyses were carefully made, using accurate elastic formulæ developed on the basis of the Castigliano theorem, including effects of shear. Special formulæ for analysing arch elements subjected to non-uniform loads were developed, but are not included herein, since similar equations have already been published.[1] Elastic formulæ for circular, constant thickness arches, carrying uniform radial loads, are too well known to need citation. Constants used in the analyses were Poisson's ratio, 0·20; modulus of elasticity in tension and compression, 2,500,000 lb. per square inch; shearing modulus, 833,000 lb. per square inch, reduced from 1,042,000 lb. per square inch to allow for non-linear variation of shearing stress; coefficient of thermal expansion, 0·0000056; and unit weight of concrete, 150 lb. per cubic foot.

BARTLETT DAM

Bartlett dam is a reinforced concrete, multiple-arch structure, with relatively short gravity sections at the abutments and a reinforced concrete, gate-controlled spillway at the right end, looking downstream. It is approximately 750ft. long, exclusive of the spillway, 288ft. high above the lowest foundation level, and contains ten multiple-arch barrels supported by hollow, double-walled buttresses of the type proposed by Fred. A. Noetzli in 1924.[2] The dam is slightly curved in alignment, so as to fit the canyon topography most economically. Thus far it is the highest multiple-arch dam ever constructed. Fig. 1 shows a general plan and downstream elevation of the dam. Fig. 2 shows a typical plan and elevation of the multiple-arch and buttress sections.

The multiple-arch barrels were designed with

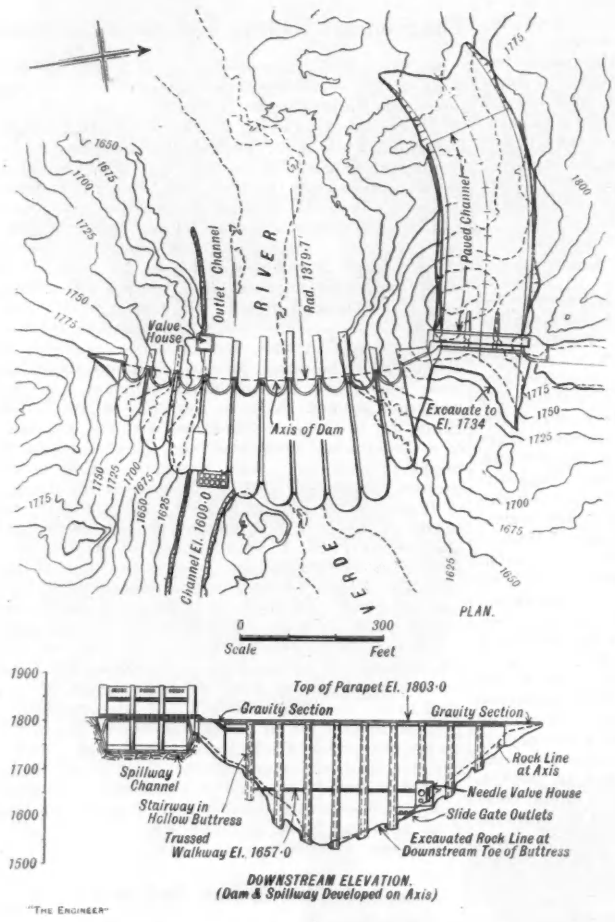


FIG. 1—*General Plan and Downstream Elevation of Bartlett Dam*

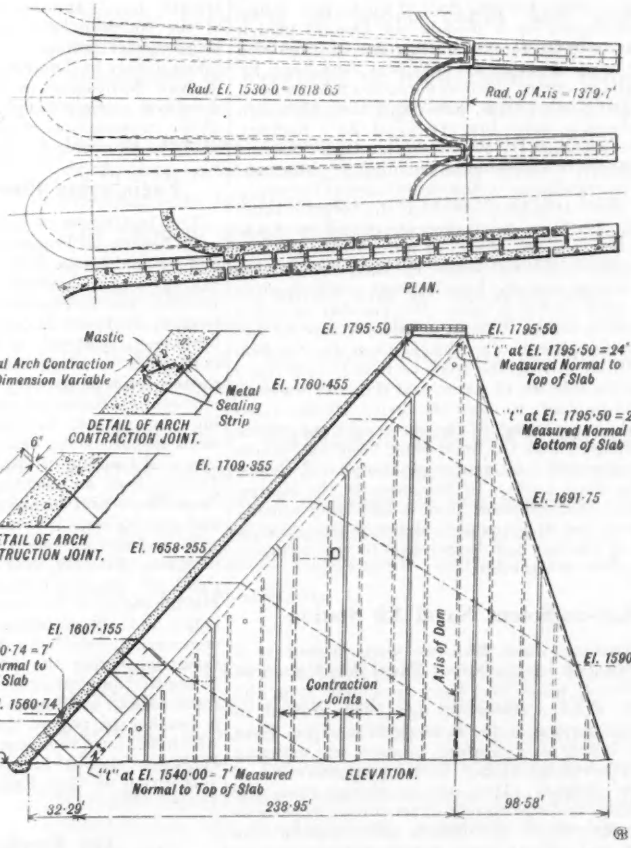


FIG. 2—*Typical Plan and Elevation of Multiple-Arch and Buttress Sections of Bartlett Dam*

* Senior Engineer, Technical Investigations, Bureau of Reclamation, Denver, Colorado.

[1] "Stresses in Inclined Arches of Multiple-arch Dams," by George E. Goodall and Ivan M. Nelidov, "Trans.," Am. Soc. C.E., Vol. 98, 1933, pages 1200 to 1239.

[2] "Improved Type of Multiple-arch Dam," by Fred A. Noetzli, "Trans.," Am. Soc. C.E., Vol. LXXXVII, 1924, pages 342 to 413.

26·3ft. at the top of the barrel to 31·9ft. at the lowest elevation. The slope of the arch barrel in vertical planes, which is the same as the slope of the upstream end of the buttress, is 0·9; so that the vertical angle between the barrel and the horizontal is 48 deg. The slope of the downstream end of the buttress is 0·36.

Inside faces of double wall buttresses are vertical and 8ft. apart at all elevations. They are connected by 18in. vertical cross walls, spaced approximately 20ft. apart horizontally along the buttress, to provide adequate stiffness against lateral displacements. Outside faces of buttress walls are slightly inclined, the thickness of each buttress wall increasing gradually from top to bottom and from downstream end to upstream end, as shown in Fig. 2. Arch reinforcing bars were extended a minimum distance of 3ft. into the buttress walls; so that the arch abutments are directly connected to the buttresses.[3]

Bartlett dam was built to provide supplemental storage for irrigation in the Verde and Salt River valleys near Phœnix, Arizona. Needle valves and slide gates were installed for use in discharging irrigation water, the sills of the latter outlets being placed at an elevation 188ft. below full reservoir surface. Since the surface may be drawn down to comparatively low levels during any season of the year, relatively high temperature changes, either positive or negative, may occur in practically all parts of the multiple-arch barrels.

Temperature Stresses

Analyses of temperature stresses were made for the assumption that the average temperature of the concrete in any arch element may fall 40 deg. Fah. below the temperature at the time of closure, or may rise 40 deg. Fah. above the temperature at

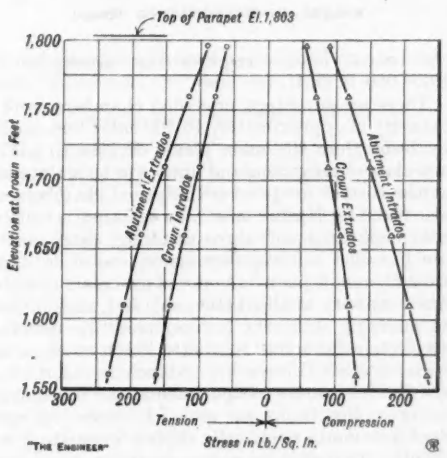


FIG. 3—*Extrados and Intrados Stresses at Crown and Abutment Sections Caused by a 40 deg. Drop in Concrete Temperature, Bartlett Dam*

the time of closure, during any condition of reservoir storage, either empty, partially full, or full. This provides for a total temperature change of 80 deg. during any condition of water load. Maximum temperature changes during the full condition of the reservoir will be somewhat smaller than during the empty condition of the reservoir, especially at the lower elevations. Such conditions were considered in some of the stress analyses. However, in this article no reductions in assumed maximum temperature change are made for the full condition of loading, since no separate analyses were made for stress effects caused by shrinkage and water soaking.

Extrados and intrados stresses at the crown and abutment sections, caused by a 40 deg. drop in concrete temperature, are shown in Fig. 3. These stresses are due to temperature change alone. They do not include effects of water load or concrete weight. Extrados and intrados stresses at the same locations, due to a 40 deg. rise in concrete temperature, are numerically equal to those shown on the diagrams, but have opposite algebraic signs. In other words, stresses due to a temperature rise are tension at the abutment intrados and crown extrados, instead of at the abutment extrados and crown intrados, as shown for the temperature drop. Due to the 180 deg. central angle, crown temperature thrusts cause only shear at the abutments. Consequently for abutment sections temperature stresses at the extrados and intrados are numerically equal, but of opposite algebraic sign.

The curves in Fig. 3 show that both tensile and compressive stresses increase gradually as the depth below the top of the dam increases. This is due to the large central angle and the gradual increase in the ratio of thickness to radius of curvature, as may be seen by referring to the recently published temperature stress curves for arch dams.[4] However, it should be noted that actual stresses plotted in Fig. 3 are slightly different from those shown on the above-mentioned previously published curves, due to the inclusion of slightly different abutment yielding conditions. Values of Poisson's ratio, modulus of elasticity, and coefficient of thermal expansion were the same in both cases.

Water Load Stresses

Table I compares arch stresses due to water pressure for two conditions of reservoir loading: firstly, when the water surface is at full reservoir level; and secondly, when the water surface is at the crown of the arch, the latter being the most severe condition of variable reservoir loading. Extrados and intrados stresses at crown and abutment sections are included for all inclined arch elements above tailwater surface. Stresses tabulated are due to water load only. They do not include effects of concrete weight or concrete temperature change.

TABLE I.—*Comparison of Water Load Stresses.*
Reservoir full and water surface at crown of arch.*
(Pounds per square inch.)

Elevation at crown.	Abutment.				Crown.			
	Extrados.		Intrados.		Extrados.		Intrados.	
	Reservoir full.	Water at crown.	Reservoir full.	Water at crown.	Reservoir full.	Water at crown.	Reservoir full.	Water at crown.
1795	—220†	—232	287	270	—91	—107	154	141
1760	—30	—148	359	180	100	— 67	223	95
1710	108	— 90	453	115	271	— 40	281	61
1660	176	— 60	541	82	387	— 25	316	44
1610	212	— 44	623	64	477	— 17	339	35

* Concrete weight and temperature loads not included. † — Means tension.

The data in Table I show that the variable water load causes compressive stresses at the intrados at both crown and abutment locations, and tensile stresses at the extrados at both crown and abutment locations. The full reservoir load causes tension at the crown extrados of the top arch, tension at the abutment extrados of the two upper arches, and compression at all other locations at both crown and abutment sections. The extrados tension at the higher elevations during full reservoir operation is due to the fact that the non-uniform portion of the full water load on the upper portions of the barrel is relatively more important than the uniform portion of the water load. In the case of the top arch the reservoir surface for the full condition of loading is only 3ft. higher than the crown of the arch; so that stresses for reservoir full are nearly the same as those for the most severe condition of variable reservoir load.

The data in Table I show that the consideration of stresses caused by variable water loads may result in the requirement of additional reinforcing steel along the upstream face of the arch barrel. Extrados tension stresses caused by variable water loads are reduced somewhat by beam action, as discussed later. However, beneficial results of beam action in reducing tension stresses at the abutment extrados, where variable water load tension stresses are most pronounced, may be offset by increases in tension caused by wave action, wave action tending to raise the water surface at the abutments. Comparative tabulations of all stresses in the arch elements of Bartlett dam, not including considerations of beam action or wave effects, for both reservoir full and variable reservoir loads, showed that a design based on the former load condition, without consideration of the latter, would have failed to provide reinforcement for extrados tension stresses varying from 12 lb. to 118 lb. per square inch at the abutment and from 16 lb. to 67 lb. per square inch at the crown, the higher values occurring in the arch with a crown elevation of 1760 in both cases.

The tabulations mentioned above, not reproduced herein, show that the consideration of extrados tension due to variable water loads is more important for the abutment sections than for the crown sections, and more important for the upper portions of the dam than for the lower portions. The variable water load, represented by the difference in head between the crown and abutment sections, is approximately the same for all arch elements, inasmuch as the inclination of the arch elements and the clear span between abutments are both constant from the top to the bottom of the dam. Consequently, arch stresses due to variable water loads decrease as the depth below the top of the dam increases, due to the gradually increasing arch thickness.

Both tension and compression stresses in the inclined arch elements of multiple-arch dams may be temporarily increased during variable reservoir loads, due to wave action. As mentioned by Lars R. Jorgensen in his discussion of Messrs. Goodall and Nelidov's article, cited above, waves sometimes have a tendency to run up the V-shaped spaces at the buttresses, causing higher water surfaces at the arch abutments than at the crown. An analysis for the inclined arch with a crown elevation of 1710, assuming the reservoir surface to be at elevation 1710 at the crown and 5ft. higher at the abutments, showed increases in stress of 10·0 per cent. at the crown extrados, 13·1 per cent. at the crown intrados, 21·1 per cent. at the abutment extrados, and 19·1 per cent. at the abutment intrados. The increase in reservoir elevation due to wave action was assumed to begin halfway between the crown and abutment and to vary on a uniform slope to the maximum amount of 5ft. at the abutment.

Fig. 4 shows the variation of stress in the arch

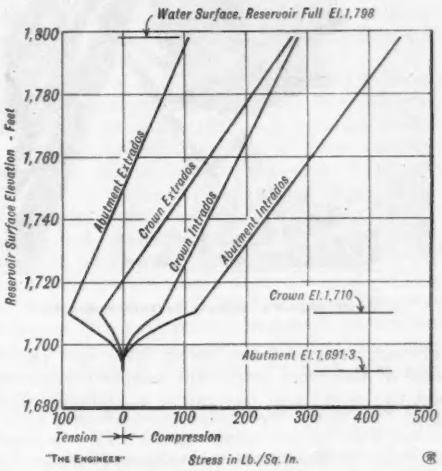


FIG. 4—*Crown and Abutment Stresses Due to Water Load, Inclined Arch with Crown at Elevation* 1710, *Bartlett Dam*

with a crown elevation of 1710, 93ft. below the top of the dam, as the reservoir surface rises or falls between the abutment elevation of 1691·3 and the full reservoir level of 1798. Extrados and intrados stresses are shown for both crown and abutment sections. All stresses vary directly with the head when the reservoir surface is above the crown elevation. Consequently, stress curves are straight lines for surface elevations higher than 1710. Stresses shown are for water load only. They do not include effects of concrete weight or concrete temperature change.

The curves in Fig. 4 show that the most severe condition of variable reservoir load, from the viewpoint of extrados tension, is when the water surface is at the crown of the arch. Both crown and abutment tensions decrease as the reservoir surface falls below the crown, or rises above the crown. In the case illustrated the crown extrados stress decreases to zero and changes to compression when the reservoir surface rises to an elevation

[3] "Bartlett Dam, Salt River Project, Arizona," by E. R. Dexter, Dams and Control Works, second edition, 1938, pages 85 to 90; Bureau of Reclamation, Denver, Colorado.

[4] "Arch Deflections and Temperature Stresses in Curved Dams," by Ivan E. Houk, THE ENGINEER, April 2nd, 1937, pages 382 to 384.

about 11ft. above the crown. The abutment extrados stress decreases to zero and changes to compression when the reservoir surface rises to an elevation about 40ft. above the crown.

In connection with the study of Fig. 4 it is interesting to note the convergence of the crown extrados and crown intrados stress curves as the reservoir surface rises; also the fact that the crown intrados compression exceeds the crown extrados compression. In a single-arch dam, where the arch elements are horizontal, stresses at the crown section are usually a relatively high compression at the extrados and a relatively low compression or tension at the intrados. The somewhat opposite conditions in the multiple-arch element considered in Fig. 4 are due to the inclination of the arch and the accompanying non-uniform head from the crown to the abutments, the head increasing toward the abutments. The convergence of the crown extrados and crown intrados stress curves as the reservoir surface rises is due to the gradually increasing effect of the uniform part of the water load, represented by the head above the crown, as compared with the constant effect of the non-uniform water load between the crown and abutments, the abutments for the arch considered being 18·7ft. lower than the crown. If a lower arch element had been chosen in preparing Fig. 4, or if stresses had been analysed for still higher reservoir water surfaces, which are not possible because of the definite height of the dam, the crown extrados and crown intrados stress curves would cross and the crown stresses would become more nearly like the crown stresses in a single-arch dam.

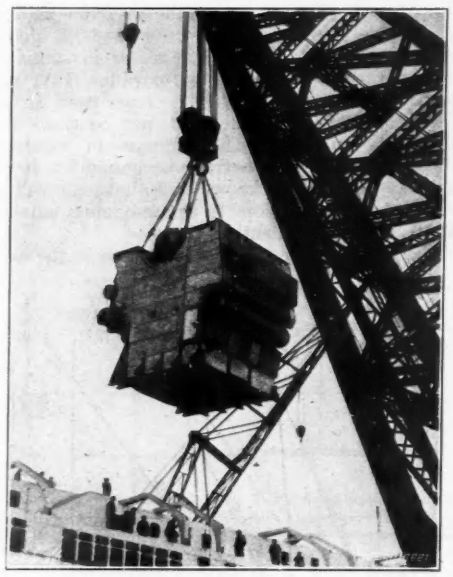
(To be continued)

Cunard White Star Twin-Screw Liner "Mauretania"

No. IV

(Continued from page 793, June 30th)

IN our three previous articles we have dealt with the general design of the liner, her main propelling machinery, steam generating plant, and electrical generating installation. In the accompanying engraving we show one of the six main boilers of the ship being slung aboard, a view which was unavoidably omitted from our last article, and which gives a clear indication of the compact design of the boiler. We now pass to some of the more important auxiliary machinery and the safety and navigation equipment of the ship.



MAIN BOILER BEING SLUNG ABOARD

Refrigerating Installation

The refrigerating plant was supplied by L. Sterne and Co., Ltd., of Crown Works, Glasgow, and is the largest fitted to any of the Cunard White Star Line vessels. The main plant, consisting of three electrically driven CO_2 compressors, and illustrated herewith, is housed in its own engine-room, while in addition to the main plant, a number of small automatic Sternette Freon compressors are installed.

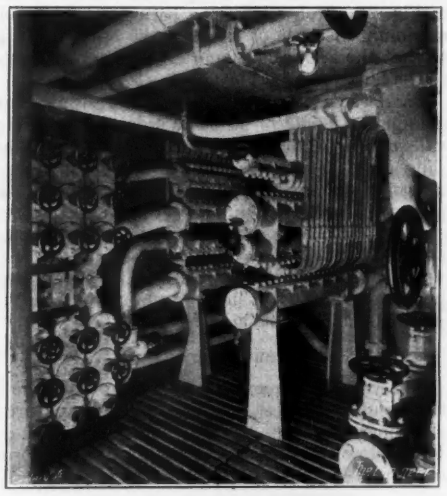
The three main CO_2 compressors—see the accompanying engraving—are of the single-acting, vertical enclosed, Haslam marine type, and are designed to maintain the required temperatures in the cargo chambers and provision chambers and to cool the water required for the Carrier air conditioning plant. They are coupled directly to variable-speed electric motors. The compressors are arranged for multiple effect working and each has its own condenser and liquid pre-cooler of the latest float-operated type. Normally each compressor operates on its own particular duty, but they are interconnected so that any compressor can work on any duty. The photograph we reproduce was taken with the machine in the foreground running at full speed. The sharp lines indicate the lack of vibration.

The three condensers are of the vertical cylindrical type with casings split on the vertical centre line to facilitate the easy removal of the spiral copper condenser tubes. Circulating water for the CO_2 condensers is supplied by two vertical spindle pumps situated in No. 1 boiler room, and each is designed to deliver 66,000 gallons of water per hour. The cargo and provision chambers are supplied with brine from two rectangular brine evaporators, which are placed in an insulated brine room in the compressor room. We show a view of the forward end of this room and the freezing, thawing, and chilling valves, also the air coolers and the flow and return headers. Three horizontal electrically driven brine pumps are installed in the evaporator room for circulating brine, the motors being in the compressor room. In addition, a booster brine pump for clearing air locks is fitted.

The lay-out of the plant has been so designed that any part of any unit can be removed without dismantling any other portion of the plant.

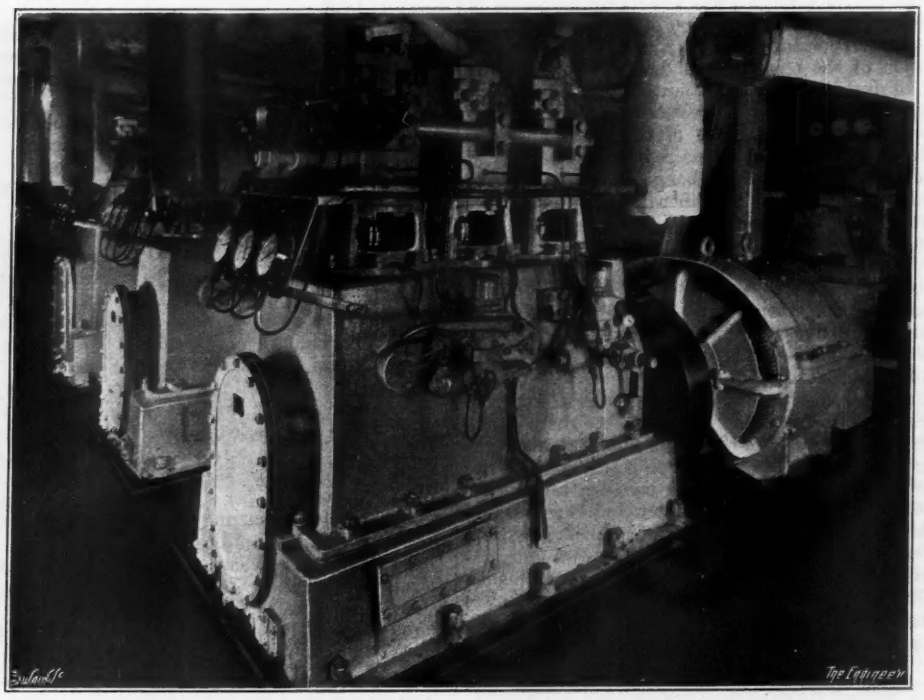
The eight cargo spaces have a capacity of approximately 92,000 cubic feet, and four of them are cooled by Sterne's latest pattern of cross-current air cooler, designed to maintain a temperature of 10 deg. Fah. for frozen produce or higher temperatures for the storage of fruit, eggs, &c. Each of the cargo spaces has its own independent battery and fans in order to enable entirely different commodities to be stowed in each space. The air is delivered and returned through ducts fitted down each side of the insulated holds, and the delivery air ducts are buried in the roof insulation, while provision is made for changing the air. The other four cargo chambers are fitted with brine grids on the deck head, sides, and ends. Special de-frosting arrangements are incorporated to ensure rapid and complete thawing of the snow on the brine grids and air cooling batteries.

The evaporators for the cooling of the water for the air conditioning plant are situated in the compressor room and are of the rectangular type, the cooling of the water being by the direct expansion of the CO_2. The refrigeration duty for the air conditioning of the cabin class dining salooon, the cabin class lounge, the tourist dining saloon, and the tourist lounge requires the absorption of 1,655,000 B.Th.U. per hour.



VALVES IN EVAPORATING ROOM

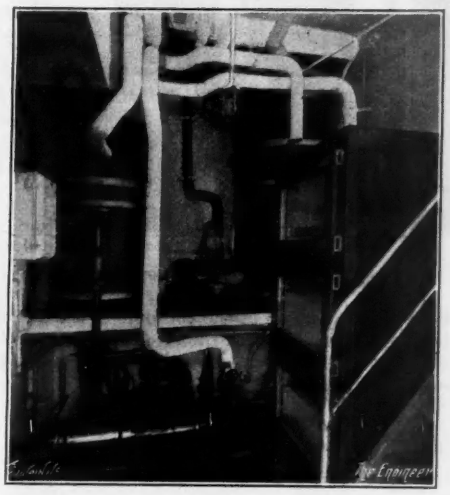
There are seventeen provision chambers, with a capacity of approximately 16,500 cubic feet, cooled by brine from the main plant, divided to enable any class of provisions and liquors to be maintained at the correct temperature. Special chambers are also fitted for Kosher meat. In addition, seventeen cold cupboards and three drinking water coolers are installed in the galley space, cooled by brine from the main plant. A special ice-cream chamber has a capacity of about 600 cubic feet, and in order to maintain it at the low temperature required, an electrically driven Sternette Freon machine has been installed. Eleven cold cabinets, some of which are divided into six compartments, and six drinking water cooling tanks are cooled by seven independent automatic electrically driven Sternette Freon plants. Two of these units operate on small brine coolers, brine being distributed to various cabinets and water coolers by a small brine pump. The cabinets and water coolers are situated on the promenade, main, A, and B decks. We show a



REFRIGERATING MACHINERY ROOM

photograph of No. 2 unit, which cools several cabinets.

The arrangements for the supply of iced drinking water have been specially designed to meet the requirements of the American tourist passengers, so that there may be a very ample supply of exceptionally cold drinking water available even when the vessel is cruising in tropical waters. In order that cold water may be instantly available at all draw-off cocks or fountains special arrangements have been made to ensure that the cold water circulates continuously through the supply pipes. The hospital is furnished with its own self-contained refrigerated cabinet, operated by a super-silent automatic Sternette Freon machine, and a



NO. 2 REFRIGERATING UNIT

special Sternette cabinet is installed in the engineers' messroom.

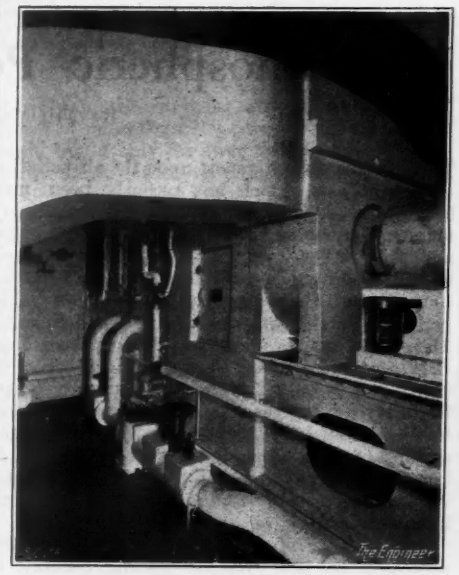
AIR-CONDITIONING INSTALLATION

The whole of the air-conditioning plant was designed and supplied by the Carrier Engineering Company, Ltd., of 24, Buckingham Gate, London, S.W.1. It includes all the features of the most recent land installations modified to meet the heavier duties of marine service. The plant provides comfortable conditions of temperature and humidity in the cabin dining saloon, grand hall, tourist dining saloon, cinema, and lounge under all weather conditions likely to be met with in Atlantic or cruising services. In hot weather temperature reductions up to 15 deg. Fah. are possible, whilst in very warm, humid weather the relative humidities may be as much as 35 per cent. lower within the rooms served by the installation than outside. A minimum winter temperature of 10 deg. Fah., or 22 deg. Fah. below freezing, formed the basis of the heating and humidifying capacity of the installation, which, in such weather, will be capable of maintaining internal temperatures of 70 deg. Fah. with a relative humidity of 45 per cent. The cabin dining saloon is served by two plants of equal capacity comprising supply fan, dehumidifier, steam heater batteries, and automatic control dampers, whilst each of the other rooms is served by a single equipment, thus providing each room with independent control. They have a combined capacity of approximately 3,500,000 cubic feet of air per hour. Refrigeration is supplied from CO_2 machines associated with the ship's main refrigerating machinery, already described, and is distributed by means of cold water which is sprayed in the various dehumidifiers. As the air-conditioning machines are distributed throughout the ship, automatic controls are rendered necessary to take care of the hourly variations in the weather and the occupancy of the rooms, with the minimum attention from the engineers. A pneumatic automatic control system is used, and the thermostats in the rooms and on the various plants regulate the flow of compressed air to motors which adjust dampers, and automatic valves, which, in turn, control the admission of steam to heaters. In this way, the temperature and humidity of the air supplied to the rooms are varied automatically to maintain comfortable internal conditions, irrespective of the weather and the variation in the number of people in the rooms.

Although the various air-conditioning plants differ in arrangement, each comprises essentially a supply fan, a Carrier marine type dehumidifier, a preheater and main heater, automatically operated air dampers, and, in the case of rooms other than dining saloons, an exhaust fan to maintain balanced conditions of pressure in the rooms.

A view of the installation supplying the tourist lounge reproduced herewith shows the external view of the air-conditioning machine. A diagrammatic drawing of the machine illustrating the method of working is also given on this page.

The dehumidifier is the source of the conditioned air, and therefore the most important component. It consists of a heavy galvanised sheet steel casing with a tank beneath it, while arranged in the casing is a series of special spray nozzles through which water is pumped at a high enough pressure to create an extremely dense bank of mist. The air to be conditioned is drawn through the mist, the temperature of which determines the final condition of the air. In summer the water sprayed in the dehumidifiers is cooled by means of refrigeration and so both cools and dehumidifies the air. In winter the dehumidifiers reverse their function and add moisture to instead of abstracting it from the air passing through them. All the fans associated with the installation have direct-coupled driving motors and are generally provided with speed control. Special precautions are taken in order to ensure that all the fans shall be silent in running so that no noise is communicated to the rooms served or to the ship's structure. Owing to the great differences in temperature and humidity between the air surrounding the plants and that supplied by them to the several rooms, many thousand square feet of cork have been used for insulating the equipment and ducting. Among the outstanding features of the air-conditioning installation is the system of air distribu-



AIR-CONDITIONING PLANT

tion. Uniform draughtless distribution is much more necessary with air conditioning than with ordinary ventilation, since, with the very large air quantities that must be circulated to maintain conditions in warm and humid weather, serious draughts are liable to be created with the lower temperatures and humidities that prevail.

In all the rooms on the "Mauretania" served by air-conditioning plants, not only is the necessary distribution of air effected without draught, but the means of distribution are incorporated in the scheme of decoration, without detracting from the architectural detail.

SAFETY AND NAVIGATION EQUIPMENT

The safety equipment includes the latest methods of fire protection for cargo spaces and for passenger accommodation. The lifeboats carried number twenty-four, of which eighteen are carried in gravity type davits over the sun deck, while the remaining six boats are carried in quadrant type davits on the promenade deck aft. The boats were supplied by Hugh McLean and Sons, Ltd., of Govan, and are constructed of double-skinned planking of teak diagonally laid, the design and equipment being in accordance with the Board of Trade's latest requirements. Fourteen of the boats are designed to carry ninety-nine persons each, and are fitted with Thornycroft oil engines. Two of the lifeboats are fitted with oil engines for full-power towing, while eight others are designed for sixty-eight persons, and will be propelled by oars.

Among the other deck machinery we may mention the cable capstan gear and warping winches, which are of the Clarke, Chapman type and are electrically driven. There are three bower anchors, each of which weighs about 9¼ tons. The total length of stud cable is 330 fathoms, and the diameter of the links is 3⅜in. It is of the Tayco pattern, and, like the anchors, was supplied by Samuel Taylor and Sons (Brierley Hill), Ltd. The same firm supplied the Taylor gravity davits for the eighteen lifeboats, and the four Columbus davits for the other lifeboats. Laurence Scott and Electromotors, Ltd., in addition to supplying the principal electric motors for the auxiliary machinery, supplied the ten electrically driven cargo winches.

The bridge is a large and roomy one, with wing quarters protected from the wind by curved aprons. In the enclosed wheelhouse, which is warmed by steam heating apparatus, there are housed Kelvin and Sperry compasses, and Telemotor control gear, which operates the steering gear and was supplied by Brown Brothers, of Edinburgh. Apart from the Marconi equipment, referred to below, there are water-tight door indicators

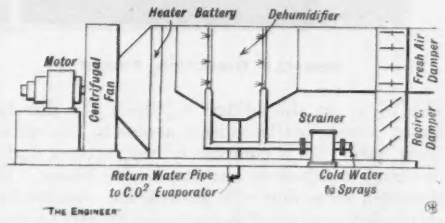


DIAGRAM OF AIR-CONDITIONING PLANT

and telegraphs, engine-room telegraphs, revolution indicators, rudder indicator and indicating mechanism for the navigation lights, and so on, all supplied by Siemens Brothers and Co., Ltd.

In the matter of wireless communication, the new "Mauretania" sets up a new standard in ship equipment. It is fitting that she should be equipped with the most up-to-date Marconi wireless apparatus because the original "Mauretania" was concerned with some interesting wireless history. When the original "Mauretania" was equipped with wireless telegraphy apparatus, there was not a single wireless direction finder at sea, and she was noteworthy as being the first merchant ship in which wireless was used for direction and position finding. The Marconi-Bellini-Tosi system was installed experimentally early in 1912, and tests were made by Marconi engineers during her Atlantic crossings.

The new "Mauretania" is equipped with comprehensive and specially designed Marconi equipment, so as to enable the following services to be carried out:—The reception of Press messages, long-wave telegraphy, medium-wave telegraphy, short-wave telegraphy, short-wave commercial telephony, continuous distress watch, direction finding, and emergency transmission on 600 metres. In order to provide these services nine aerials and three separate transmitters are employed, one for each of the short, medium, and long-wave channels. The medium and long-wave transmitters will be used for telegraphy only, but the short-wave transmitter is suitable for both telegraphy and telephony.

Four separate telegraphy receivers, one for short waves, one for medium waves, one for long waves, and one for Press reception, are installed. All these receivers are of the same type and can be used for any of the four services, but they will normally be reserved for particular channels.

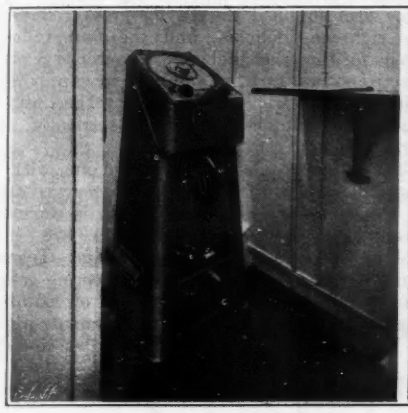
In addition there is the short-wave telephony service, which will enable passengers to communicate with telephone subscribers on shore. Booths have been placed near the telegraph office and the lifts so as to be readily accessible for passengers receiving incoming calls. The telephone equipment is a compressed replica of an inter-Continental wireless telephone installation and will permit passengers to communicate with any subscriber either ashore or in a similarly equipped ship in any part of the world. It will also enable broadcasting to be carried out from the ship and relayed by broadcasting systems on both sides of the Atlantic.

The latest pattern direction finder, of the Marconi-Bellini-Tosi type with fixed aerial and rotating goniometer, has been installed. This has been designed primarily for use on the bridge and is housed in a robust casting which is mounted directly upon the deck; it is illustrated herewith. It presents an appearance similar to that of an

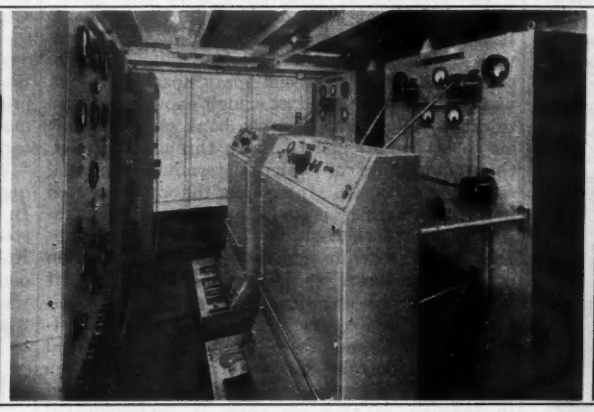
ordinary binnacle, so constructed that the direction finding scale is inclined towards the observer and affords clear and accurate observation of bearings. The second scale on this instrument is coupled to the Sperry gyroscopic compass so that true Great Circle bearings may be directly observed. A loud-speaker is contained in a panel below the scale.

relaying a broadcast programme, other rooms can be receiving music from gramophone records or the ship's orchestra relayed by means of a microphone. The programmes are completely interchangeable and can be altered at will from a central control panel.

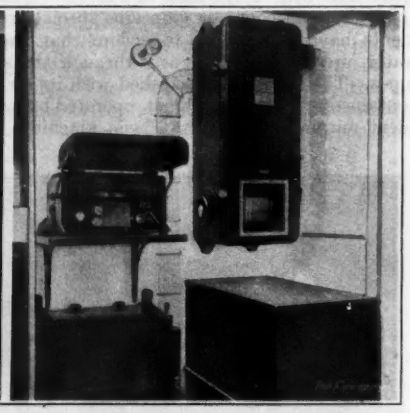
On the bridge there is a Marconi "Echometer" vary. Two means of indication, the visual indicator and the automatic recorder, are provided. With the visual indicator the depth of water under the keel is shown many times a minute by a "peak" of light on a calibrated scale. The recorder, in addition to providing depth indication, automatically plots a graph of the contours of the sea



BINNACLE DIRECTION FINDER



MEDIUM AND LONG WAVE TRANSMITTERS



ECHOMETER SOUNDING DEVICE

The room on the bridge in which the direction finder is installed has direct access to the officers' chart room. It is completely copper lined and all incoming conductors are fitted with filters. This thorough screening will protect the circuits from ship's electrical interference and so greatly facilitate operation with a resultant improvement in performance.

Another special feature of the installation is the auto-alarm equipment, which maintains an automatic 600-m. watch for twenty-four hours per day. In the event of an alarm call being received this instrument rings bells to call the attention of the radio officer and officer of the watch. A loud-speaker can also be used if required. This auto-alarm is of unusually strong construction and a special test unit is incorporated in it so that the sensitivity can be checked at any time. A standard spark emergency transmitter, tuned to 600 m., is also fitted near the automatic alarm, and is designed to work from an emergency battery. It forms the most powerful spark emergency equipment which can be offered under international regulations. The advantages of the wide frequency band of spark transmitters for real emergency work are fully recognised and the design of the transmitter makes it especially suitable for this purpose. Seven radio officers will be carried to enable the comprehensive services to be carried out speedily and efficiently. Power for the transmitters and receivers is provided by three dynamos and the total power used for carrying out all the services concurrently will be less than 30 H.P.

With the exception of the lifeboat equipment of two motor launches, the wireless apparatus occupies four positions in the ship. The three alternators are in the wireless alternator room, the transmitters in the transmitting room, the direction finder on the bridge, and the remaining equipment, including all receivers, emergency transmitter, automatic alarm, &c., in the main wireless control room, a view of which is reproduced in the engraving above.

The whole of the equipment, with the exception of the direction finder, is controlled from the main wireless control room. This includes starting and stopping machines, adjusting the power and type of emission of the transmitters, keying, &c. There is also telephone communication between the wireless control room and the three other wireless posts, and communication with the pursers' and the ship's intercommunication system.

In addition to the wireless equipment already described, Marconi sound reproducing equipment to provide entertainment in all parts of the ship from radio, gramophone or microphone sources is installed. A specially designed receiver is incorporated in order to receive broadcast programmes, which can be distributed to any of the numerous loud-speakers which are installed in the public rooms in all parts of the ship. About fifty loud-speakers are fitted in the lounges, smoke-rooms, verandahs, dining saloons, and the Grand Hall. Following recent research in acoustics in order to attain a better distribution of sound, a large number of speakers have been distributed throughout a room. Volume controls are fitted in each room so that the sound can be adjusted.

The main feature of the whole installation is its great flexibility. While certain rooms may be

sounding device, which has been designed to give instantaneously and correctly, and irrespective of the speed of the vessel or weather conditions, the depth of water under the keel, however it may

bed. A comparison of the contours of the sea bed in known positions with the contour obtained aids the navigator to fix the ship's position with accuracy.

Atmospheric Pollution, 1937-38

By THOMAS McLACHLAN

THE twenty-fourth report upon the air-pollution observations, which has recently been published, shows that eighty-eight bodies (eighty municipal authorities, five industrial undertakings, and three other institutions) are co-operating in the collection and cost of collection of data relating to the state of the atmosphere in this country. The period covered relates to the year ended March 31st, 1938, and copies may be obtained from H.M. Stationery Office. The cost of the report for this period is only 2s., as compared with 7s. 6d. for last year, but there is now a supplement containing detailed data, not required by most people, at a cost of 4s. 6d. In order to bring the format into line with most Government publications, the volumes are now in octavo size instead of the old familiar quarto.

The number of deposit gauges unfortunately decreased to 123, Glasgow having reduced its gauges from sixteen to six, and observations having been ceased at Ashington and Cheltenham, whilst new gauges have been installed at Grimsby and Stirling. The London County Council has moved its gauges from Rustington to Margate. During last year three fresh gauges were installed at Scunthorpe, and although the results from them will not be generally available until next year, figures from this town for the year 1938–39 are included in this report for comparison in certain instances. The number of automatic filters exposed remains at sixteen, and sulphur pollution is still measured at eleven stations by the hydrogen peroxide method, whilst the number of lead peroxide cylinders has been increased from forty-three to forty-seven. All these observations are independent of the research which has been carried on around Leicester and for which figures are not yet available.

The report contains an interesting note (pages 102–107) by Dr. J. S. Owens on fog formation, and describes the difference between fogs due to water droplets and those due to smoke, though it is mentioned that one seldom gets the latter without its being associated with the former. As Dr. Owens points out, the reason for a smoke fog is that the wind fails to act as a perfect scavenger and clear away the smoke, in exactly the same way that pollution of a river or stream is caused by an excessive discharge of objectionable matter, which cannot be adequately dealt with by the volume and rate of flow. It is really remarkable that a country which prides itself on leading the world in civilisation should be content to endure fogs of an objectionable character and without necessity. It is true that we no longer have to submit so frequently to the "pea-soup" fogs of our youth, but this is no reason why more efforts should not be made to see that we suffer, as far as possible, only from water vapour fogs, which are an "act of God" and cannot be prevented. Since the author of this note does not entirely agree with the belief that atmospheric pollution is mainly a matter of smoke, he does not go all the way with Dr. Owens in attributing the whole of a smoke fog to true smoke or fume, when it is associated with a fog due to water vapour. In order to encourage the condensation of water vapour it is essential that particles in the air shall be either hygroscopic or coated with a hygroscopic material. Thus particles of sulphuric acid will definitely assist in the formation of a fog, and once a fog has commenced over a town one notices how the acidity of the fog increases with its continuation and with the lighting of smoky flares and fires to give a modicum of light to fog signallers or heat to cold townsfolk. At the same time, other particles in the atmosphere will tend to cause the collection and condensation of water; and as an indication of forces which may play a part, it is interesting to note that polished glass is always surrounded by a film of moisture to a much greater extent than unpolished glass. For this reason it has always been difficult for the author to understand why we cool down the products of combustion of coal at power stations to remove grit and sulphur fumes, and then heat them up again with water vapour to carry them into the atmosphere, where they may be seen to condense on suitable occasions without a fog, and when there is a fog, they must add considerably to the trouble.

STATISTICS

Following the plan which has been previously adopted in this series of reports in THE ENGINEER, towns and cities have been grouped into three sections according to total deposit collected in the deposit gauges.

The results are shown in Table I.

Comparison of this table with those of previous years shows that there are nineteen towns in Group 1 with thirty-two gauges, and that the average deposit is only 137 tons per square mile, which is much better than it has been for some years. Group 2 contains approximately the same number of towns but with fewer gauges and the deposit averages only 235 tons per square mile. Both these groups show an average of over 10 tons less deposit per square mile than for some years previously, and it is to be hoped that this improvement will be maintained. The third group,

unfortunately, appears to be worse than for a number of years, but this is accounted for largely by the heavy deposit at Pontefract and by the

TABLE I.—*Comparative Figures for the Total Collection of Solid Matter in Forty-two Towns and Cities of the United Kingdom during the Twelve Months Ended March 31st, 1938*

City or town.	No. of gauges.	Tons per square mile per annum. Total solids.	Sulphur as SO_3.
Group 1, under 200 tons :			
Loggerheads	1	53·88	10·08
Rothamsted	1	79·20	—
Godalming	1	89·40	13·20
Marple	1	89·64	15·60
Southport	2	107·28	13·44
Wolverhampton	1	123·00	16·20
Gloucester	1	124·20	—
Walsall	1	125·16	13·44
Bournville	2	127·20	11·04
Loughborough	2	135·24	—
Cardiff	1	137·40	14·04
Garston	1	138·96	19·32
Wallsend	1	161·88	16·20
Edinburgh	3	166·44	17·28
Southampton	1	171·00	15·36
Huddersfield	2	191·16	30·24
Coventry	3	192·24	21·60
Halifax	5	197·28	22·32
Leicester	2	197·40	24·96
	32 (total)	137·26 (average)	17·15 (average)
Group 2, 200 to 300 tons :			
Bristol	2	205·44	19·32
Dewsbury	3	206·04	25·44
Shipley	1	210·84	26·28
Burnley	4	211·44	19·32
Bradford	2	213·12	23·76
Kingston-upon-Hull	3	214·20	35·04
Sheffield	6	218·76	21·12
Newcastle-upon-Tyne	2	225·60	32·16
Salford	3	237·60	27·00
Rotherham	2	239·28	21·72
Leeds	5	240·12	22·20
Wakefield	3	248·52	29·64
London	13	250·20	31·08
Stoke-on-Trent	3	250·20	23·40
Glasgow	5	253·80	30·48
St. Helens	1	279·72	25·08
Liverpool	3	285·12	23·16
	61 (total)	234·71 (average)	25·66 (average)
Group 3, 300 tons and over :			
Castleford	1	324·36	43·20
Birmingham	2	329·88	—
Hove	1	366·60	51·72
Widnes	2	386·28	54·00
Pontefract	1	603·72	44·40
	7 (total)	402·17 (average)	48·33 (average)

installation of gauges in the last year or two at Widnes and Hove, of which the latter is affected

TABLE II.—*The Total Deposit of Solid Matters and Sulphur Collected in the London Gauges during the Six Separate Years, 1933–34–35–36–37–38*

Solid Matters

	Tons per square mile per annum. 1932–33.	1933–34.	1934–35.	1935–36.	1936–37.	1937–38.
East and Central Districts :						
Golden Lane	344	644	536	292	261	294
Archbishop's Park	331	346	407	435	322	279
Horseferry Road	327	399	322	344	480	460
Southwark Park	234	243	217	258	244	252
Finsbury Park	233	376	390	405	273	198
Victoria Park	208	226	224	224	209	208
Averages for five gauges	267	318	312	333	305	279
West and South-West Districts :						
Ravenscourt Park	472	—	242	293	210	207
Mount Street	291	270	262	293	314	385
S. Kensington(M.O.)	192	191	259	228	219	243
Wandsworth Common	163	179	154	183	172	181
Kew Observatory (S.)	134	120	123	131	128	141
Kew Observatory (N.)	115	116	114	125	117	125
Averages for five gauges	179	175	182	192	190	217

Sulphur

	Tons as SO_3 per square mile per annum. 1932–33.	1933–34.	1934–35.	1935–36.	1936–37.	1937–38.
East and Central Districts :						
Golden Lane	46	110	100	38	39	42
Archbishop's Park	42	38	44	46	43	34
Horseferry Road	29	42	28	33	44	45
Southwark Park	28	31	24	35	24	31
Finsbury Park	28	63	89	99	27	25
Victoria Park	28	23	24	30	21	23
Averages for five gauges	31	39	42	49	32	36
West and South-West Districts :						
Ravenscourt Park	107	—	64	48	32	30
Mount Street	39	21	23	30	36	46
Wandsworth Common	26	23	23	25	22	26
S. Kensington (M.O.)	23	26	31	32	27	32
Kew Observatory (S.)	18	18	18	21	20	18
Kew Observatory (N.)	16	17	15	20	17	20
Averages for five gauges	24	21	22	26	25	28

to a considerable extent by sea water. In this connection it is interesting to note that the prevailing winds in this country come from the south-west, and that Brighton faces this direction; whereas, although the rainfall is much heavier on the west coast than on the east, the deposits at Southport are comparatively small. The reason for this would appear to be that Brighton receives more or less the full force of the Atlantic, in spite of its position, whereas Southport basks in the shelter of Anglesey, and Liverpool, of course, is protected to an even greater extent.

Apart from towns such as Hove, where a large percentage of the deposited matter is obviously derived from the sea and sea-borne material, it seems almost ludicrous to be able to state that the average deposit in the nineteen towns included in the first group is "only" 137 tons per square mile, when one must appreciate that it is probably unnecessary for any town to have a deposit of more than 100 tons per square mile, if people would only do away with open coal fires, remove all dust with vacuum cleaners, mount all vehicles on pneumatic rubber tyres, spray buildings in process of demolition with water to keep down dust, insert filters in chimneys of factories, &c.

Table II contains the detailed figures of the London observations for the total solids and sulphate sulphur for the last six years. Although the figures are given for Golden Lane and Ravenscourt Park, they have been omitted in calculating the averages, so that these averages represent five gauges only for approximately eastern and western portions of the city. As has been noted previously, two of the gauges are in Kew Gardens, and can hardly be said to represent London atmosphere, whilst Horseferry Road is really in the western portion of London, so that it may be fairly claimed that the east and central gauges more nearly represent the central portions. Even so, it is noticeable that the tendency is for the deposits to decrease in the east and central districts, whilst they are definitely on the increase in the westerly parts; and if Horseferry Road were included, as it should be, in the western districts, there would be little to choose between the two portions of London. Since the increase in the London area is chiefly at the stations Horseferry Road, Mount Street, and South Kensington, there can be little doubt that it is largely connected with building operations in these districts, and it is felt that this point is insufficiently recognised.

In order to ascertain what is the connection between the total deposit in the gauges, the sulphate sulphur in gauges and the sulphate sulphur as determined by the lead peroxide method, Table III has been prepared from the official figures, and to these have been added figures for the year 1938–39 for Scunthorpe in order to make the point clearer. On the assumption that the sulphate in the deposit gauges is chiefly a measure of atmospheric pollution from chimneys burning coal, coke, or gas, and that matter collected in the gauges and on the lead peroxide cylinders are all affected more or less directly by wind currents, one would expect to find some relationship between the sulphur collected by these two methods, and no particular relationship between the sulphur collected in the rain-water gauge and the total solid matter in the gauge. In order to make the table simpler it has been arranged in the order of those stations with the greatest amount of total deposit first and in descending order.

TABLE III. — *Comparative Figures for the Total Solid Matter and Sulphate Sulphur in Deposit Gauges with Sulphate Collected by Lead Peroxide.*

Station.	Deposit gauge. Total solids. Tons per square mile per month.	Deposit gauge. Sulphate SO_3. Tons per square mile per month.	Lead peroxide. milligrammes of SO_3 per 100 sq. cm. per day.	Deposit SO_3 Total solids Per cent.	Ratios of sulphur. Lead peroxide Total solids	Lead peroxide Deposit SO_3
Scunthorpe Santon	158·08	8·94	2·54	5·6	1 : 0·016	1 : 0·28
London, Horseferry Road	39·19	3·72	2·82	9·5	1 : 0·07	1 : 0·76
Manchester, Oldham Road	39·19	3·95	4·77	10·1	1 : 0·12	1 : 1·2
London, Mount Street	32·10	3·80	3·22	11·9	1 : 0·10	1 : 0·85
Leeds, Park Square	28·15	2·60	3·00	9·2	1 : 0·11	1 : 1·2
Sheffield, Surrey Street	27·51	2·52	3·18	9·2	1 : 0·16	1 : 1·3
Halifax, Wade Street	26·85	2·32	2·45	8·6	1 : 0·14	1 : 1·6
Manchester, Rusholme	25·17	2·27	2·87	9·0	1 : 0·11	1 : 1·3
Rotherham, Technical College	24·43	2·17	3·19	8·9	1 : 0·13	1 : 1·5
Scunthorpe, Britannia Corner	23·14	2·87	1·56	12·5	1 : 0·07	1 : 0·54
Leicester, Town Hall	22·49	2·58	3·34	11·4	1 : 0·15	1 : 1·3
Salford, Ladywell Sanatorium	21·52	2·24	4·15	10·4	1 : 0·19	1 : 1·9
Stoke-on-Trent, Leek Road	18·72	2·19	3·00	11·7	1 : 0·16	1 : 1·4
Scunthorpe, Isolation Hospital	17·79	2·87	1·85	16·1	1 : 0·10	1 : 0·64
Dagenham	13·29	2·37	1·33	17·8	1 : 0·10	1 : 0·56
Manchester, Withington	13·18	2·01	2·27	15·2	1 : 0·17	1 : 1·1
Garston	11·58	1·61	0·56	13·9	1 : 0·05	1 : 0·35
Cardiff, City Hall	11·45	1·17	1·14	10·2	1 : 0·10	1 : 0·97
Halifax, West View Park	11·27	1·53	2·45	13·6	1 : 0·22	1 : 1·6
Leeds, Headingley	10·48	1·12	1·80	10·7	1 : 0·17	1 : 1·6
Sheffield, Dore	8·98	1·45	0·96	16·1	1 : 0·11	1 : 0·66
Sheffield, Ewden Waterworks	7·93	1·22	1·03	15·4	1 : 0·13	1 : 0·85

Examination of this table shows immediately that there is a more or less constant ratio between the amount of total solid matter collected in the gauge and the amount of sulphate in the gauge, although the percentage of sulphate tends definitely to increase as the amount of total solid matter collected decreases. Appreciating the fact that ash from coal and coke contains quite a percentage of sulphate, one can also understand that matter carried from chimneys will consist of fume dust, fume, and gases, it being rather hard to define the exact boundary-line between each of these conditions. There should, therefore, be some relationship between these three sets of figures similar to that shown between the deposit gauge total solids and sulphate; but it is impossible to find any relationship at all between the lead peroxide figures and other figures.

TABLE IV.—*Comparative Amounts of Sulphur as Measured by the Hydrogen Peroxide and Lead Peroxide Methods for Eleven Stations*

Town or city.	1935–36. Volumetric method, volumes of sulphur dioxide per million volumes of air.	1935–36. Lead peroxide, milligrammes of sulphur trioxide per 100 sq. cm. per day.	1935–36. Ratio.	1936–37. Volumetric method, volumes of sulphur dioxide per million volumes of air.	1936–37. Lead peroxide, milligrammes of sulphur trioxide per 100 sq. cm. per day.	1936–37. Ratio.	1937–38. Volumetric method, volumes of sulphur dioxide per million volumes of air.	1937–38. Lead peroxide, milligrammes of sulphur trioxide per 100 sq. cm. per day.	1937–38. Ratio.
Sheffield	0·139	3·37	1 : 24	0·148	2·07	1 : 14	0·145	1·95	1 : 13
Leicester	0·086	2·68	1 : 31	0·078	1·78	1 : 23	0·100	2·18	1 : 22
London : Westminster City Hall	0·139	2·72	1 : 20	0·115	3·41	1 : 30	0·135	2·93	1 : 22
Newcastle	0·114	2·91	1 : 25	0·111	3·21	1 : 28	0·110	2·96	1 : 27
Glasgow	0·084	2·89	1 : 34	0·096	2·65	1 : 28	0·090	2·56	1 : 28
London : Westminster Bridge	0·154	5·05	1 : 33	0·123	5·60	1 : 46	0·144	4·98	1 : 35
Chelsea	0·124	3·72	1 : 30	0·090	3·97	1 : 44	0·107	4·23	1 : 40
Kingston-upon-Hull	0·063	2·93	1 : 41	0·063	2·72	1 : 43	0·058	2·79	1 : 48
Salford	0·082	3·23	1 : 40	0·055	4·65	1 : 85	0·059	4·16	1 : 71

Table IV contains the figures for the eleven stations for which the lead peroxide method has been used for the last three years. Here again the ratio between the sulphur collected by the lead peroxide method and the sulphur collected in the rain-water gauge is not constant, but the ratio between the sulphur collected by the lead peroxide method and the total solid matter collected in the rain-water gauge is more or less constant. Here, again, the ratio between the sulphur collected by the lead peroxide method and the sulphur collected in the rain-water gauge tends to increase as the amount of total solid matter collected decreases.

In the report in THE ENGINEER last year it was stated that the variation in the figures for total deposits and sulphate in rain-water gauges in London could only be accounted for on the assumption that the sulphur deposit consists partly of powder from the construction or destruction of buildings. If this survey be extended to the various stations throughout the country, it will be noticed that the sulphate percentage of the total deposit tends to be lower in those areas where limestone forms the predominating building material of the older buildings, and that it is high where sandstones or grits have been employed. Examination of the tables given in the official report showing the amount of lime deposited each month tends to indicate that this remark is largely correct. As a

result, one is forced to the conclusion that a considerable amount of the blame thrown on to factories and chimneys for atmospheric pollution should be directed at house-breakers, and it is suggested that the atmosphere of many towns would be far cleaner if house-breakers were obliged to spray buildings in process of demolition with water to prevent the discharge of vast quantities of dust into the surrounding neighbourhood. At the same time, industry cannot claim to be entirely blameless, for there can be little doubt that the enormous deposit at Santon, Scunthorpe, arises almost entirely from the local steel works, and one feels that much of this could be eliminated. It is to be regretted that more authorities have not the courage to place deposit gauges in districts where a truer measure of pollution from factories could be obtained.

Last year attention was also drawn to the value of the determination of sulphur pollution in the atmosphere as compared with that determined by the lead peroxide method, and it was mentioned that whilst the former method measured the amount of sulphur pollution per volume of air, the latter gave a very good indication of the amount of active sulphur dioxide impinging on a given surface for a given time. In order to examine this point still further, Table IV has been prepared to show the ratio between the results obtained by the two methods, when these two determinations are carried out in parallel.

The results are interesting, inasmuch as the sulphur dioxide would appear to be five times as active at Salford as at Sheffield, and that its activity is intermediate in other towns. Seeing that the average wind velocity all over the country is probably very similar, it may be taken that the difference in these ratios is largely a matter of exposure to the true velocity of the wind at different stations. Thus one would expect to obtain a much fuller exposure to the action of the wind at the County Hall, Westminster Bridge, or at Chelsea, in London, than is possible at Westminster City Hall, where buildings are completely hemmed in by one another, and this is what is found in practice. What is difficult to understand is that the amount of sulphur dioxide, as determined by the volumetric method, is greater at the County Hall than at the City Hall, which is surrounded by the chimneys of offices and restaurants, and it is felt that there must be some local force coming into play at the County Hall, by which the results obtained by the volumetric method are higher than they should be.

CONCLUSION

As stated above, the results of the various exposures at Leicester are not yet available to the public, and the authorities are wisely taking a year for their examination before broadcasting them. So far only a few people are collaborating in the collection of data with regard to atmospheric pollution. The cost is high, and there has been a tendency to assume that pollution is all or chiefly due to smoke and chimneys without working out the available data completely. The complete examination of data can only be made by contributions towards the work by all parties affected, and it should be in the interest of engineers to encourage both authorities and large employers of labour to assist in this matter, because it may prove that works are not always as much to blame as has been believed. Even if they are to blame, it is possible that carefully collected data may show the type of pollution and its source. As a result, it will be much simpler to effect a remedy and it is quite possible that by-products obtained from such processes may soon more than pay for their initial cost. In this connection, observations are now beng made with regard to the discharge of metals, such as zinc, into the atmosphere of certain towns, and it is not improbable that its efficient collection might eventually give rise to a profit, after allowance has been made for the installation of suitable scrubbers.

Industries In and Around London

By JOHN HOLLOWAY

No. II—FILLING AND MOULDING

THE firm of engineers known as E. Cowles, Ltd., has been in business for more than two centuries, having been founded in 1736. The works are at Hounslow, Middlesex, and at present they are mainly engaged in manufacturing machinery for the chemical and perfumery trades, and in making metal moulds and moulding machines used in the trade for moulding waxy and fatty materials. In addition to this, the firm does a considerable business in metal refining and employs its own alloys for the high-class moulds which are now used for so many purposes. In addition, it supplies solder to the tinsmith's trade, and bearing metal in several quantities.

Many of the machines made at these works are the type used for filling collapsible tubes, tins, drums, and barrels, which are always so much in demand, for in these days people are accustomed to purchase almost every kind of commodity packed and wrapped in air-tight tins and containers of all sorts and descriptions, and which are now made in almost every variety of material, from pure tin to aluminium and lead, or from cardboard to transparent paper and Cellophane. Millions of these containers are used every week of the year. Generally, they are used but once and then thrown away as worthless. For this reason, the cartons and containers have to be made very cheaply, and they have to be filled to just the exact weight and sealed securely to prevent leakage and deterioration of the ingredient enclosed, all at a cost that is almost infinitesimal. For this reason many special types of filling and sealing machines have been designed to meet the demand. In these machines it is accuracy in quantity delivered and deposited in the container that is of first importance, and this accuracy must be maintained over long periods without variation in all the millions of containers that have to be filled. After the filling operation is completed, there comes the closing and sealing, which is no less exacting than that of filling, and when both these requirements are satisfied, there is still the question of speed to be considered, for it is the speed of operation and the number of containers that can be filled per minute that governs the cost of the filling and sealing process.

In the metal refining department of these works a special alloy is produced, for making moulds used in a number of trades for moulding soft substances such as wax and other fatty compounds. An attractive feature of this alloy is that it can be cast in any desired form, and is easily worked up to a good surface finish, either by hand or machine. The quality of surface finish is important in all moulds, because it is closely reproduced on the surface of the moulded product. Another advantage in the use of this alloy is that it is practically stainless, and does not discolour when used for moulding cosmetic pastes or medical preparations.

Many differing types of moulds are made, some being solid and others split, and in the latter special means are provided to ensure perfect location of the mating halves. In some cases single impression moulds are made, but this is generally when the required production is low or very special. In all cases of high production the multiple type mould is used. These are sometimes made to produce a dozen articles only at one filling, while others are made to yield a gross or more. Then there are bench moulds for purely hand work. There are self-contained moulding machines which, when necessary, are fitted with water or steam jackets and all necessary connections at the inlet and outlet points.

These moulding machines are simple, but robust in design, and rarely get out of order. Being multiple in character, the machine can be built to yield practically any reasonable number at each filling. For instance, one machine is made for moulding coloured nail pencils or wax crayons, which delivers 200 pencils at each filling. By means of a special device all the pencils are ejected from the mould at once by merely turning a handle. Then there is a napthalene ball moulding machine, with a capacity of 2400 balls per moulding, which is equally easily handled. Another, but rather more elaborate type of machine is made for the candle manufacturer. There is rather more mechanism in this machine because the wick of the candle has to be dealt with; nevertheless, in operation it is almost as simple as the others, and will produce 1440 candles per hour, all completely finished and ready for packing.

The engineer is not as a rule associated with candle making, but, as is seen here, he and the tool maker have quite a lot to do with the production of that commodity, just as they have with many more equally simple productions, though they may seldom get credit for it.

In these works the power house is conveniently placed close to and in line with the machine shop, and this arrangement suits the drive to the main line shaft very well. Power is taken from a 65 H.P. horizontal type Blackstone heavy oil engine, running at 240 r.p.m. The line shaft from the machine shop is driven direct from this engine by pulleys and belt. The engine also drives an electric generator which supplies current for lighting the whole of the premises. It has always been the practice of the firm to have its own power plant, and it keeps abreast of the times by changing over to more efficient plant whenever that appears advisable. With the present power plant they are satisfied that the total overall cost of power, light, and heat used throughout the works and offices is appreciably less than the cost would be if these services were taken from companies' mains.

The machine shop is equipped with the usual type of machine tools which have been found suitable for the work in hand. This means that the tools are standard pattern that can be switched over to the production of many forms of engineering work. That is an advantage when the machines produced are not of one size or pattern, but are varied in both size and type.

As already mentioned, one of the classes of machines constructed here are those known as filling and closing machines, for collapsible metallic tubes. They are made in a variety of sizes and types, from single-purpose hand-operated machines to the multi-purpose power-driven fully automatic machine. There is also an intermediate machine which is single-purpose in character, but is fitted with power drive and has a special stop clutch for convenience in operation. The advantage of the power drive even on these small machines is, of course, obvious, for not only is the output higher, but it is also more constant in speed of operation, and does not depend so much on the exertion of the operator. From this point of view, it is interesting to note the relative volume of output from the various types of machines performing similar operations. The hand machine will effectively close and seal 2in. by 10in. collapsible tubes at the rate of ten to twelve per minute, or 1in. by 5in. tubes at the rate of eighteen to twenty per minute; while the same machine fitted with clutch controlled power drive will close the 1in. by 5in. tubes at the rate of thirty per minute. In each case every tube is handled twice—that is, it is put on and taken off the machine by the operator. In the aggregate the hand-worked machine closes 9600 tubes per day of eight hours, while the power-driven machine closes 14,400 tubes in the same time. Seeing that each tube is handled twice, it follows that a tube passes through the hands of the operator 19,200 times in the former case and 28,800 times in the later case, and it must not be forgotten that the collapsible tube is a delicate thing to handle if deformation is to be avoided.

To increase output it therefore becomes necessary to use the automatic filling and closing machine in which the human element is more or less dispensed with. In this field the firm has designed and is supplying a fully automatic machine that feeds in the tube, tightens the cap, cleans the inside, fills it, closes it, and codes it for batch identification purposes. This machine works in conjunction with a conveyor which is enclosed with a table at either side of the belt, where the packers sit and receive tubes as they are delivered. The output from this type of machine performing all the operations given above is forty tubes per minute, or 19,200 tubes per day of eight hours, which means that it gets through 115,200 operations per day, the power of the driving motor being 1 H.P. A machine of this type is shown in Fig. 1.

The machine has a number of special features which, it is claimed, make it very simple and reliable. It will fill, form to shape, wipe away any excess of cream, close, and fold the open end with two complete folds, crimp or corrugate the folded end to obviate the use of the metal clip previously used, and gently eject the tube from the machine. These operations follow in proper sequence. The

tube is placed on the endless chain which moves intermittently from one station to another as the operations proceed. For filling, the tube is automatically lifted to the filling nozzle, which is fully charged to the point so that the nozzle reaches the inside shoulder of the tube, and as the tube is filled it is lowered again into the tube holder at a predetermined speed, making it possible to fill the tube without air pockets. The chain then moves to the next station where the tube is formed to shape, and any surplus cream extruded from it is collected in a tray. At the next station the tube

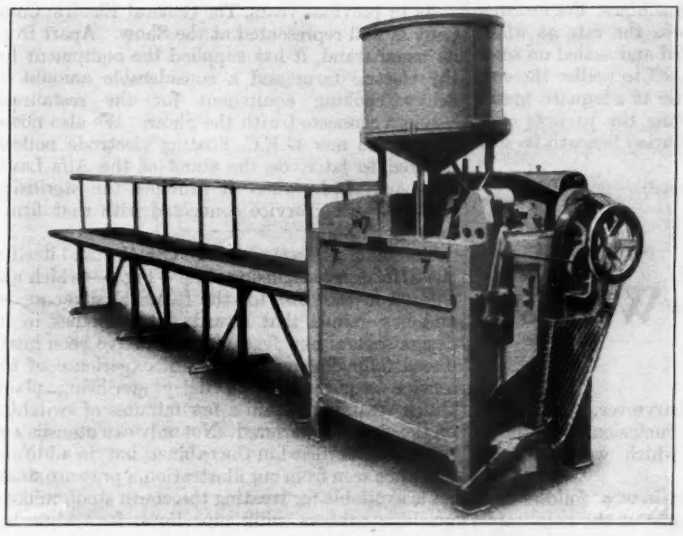


FIG. 1—AUTOMATIC COLLAPSIBLE TUBE FILLING AND CLOSING MACHINE

is hermetically closed by two completely tight folds; finally it is crimped and coded, and when it reaches the other extreme end of the machine it is automatically ejected. Arrangements are made for adjustments to the tube holders on the endless chain, and to the stroke of the pump which is also fitted with two or three pistons of different diameters, so that several sizes of tubes can be dealt with on the same machine, and perfect filling of any size tube is assured.

Other types of machinery made by this firm are power-driven mixing machines of both vertical and

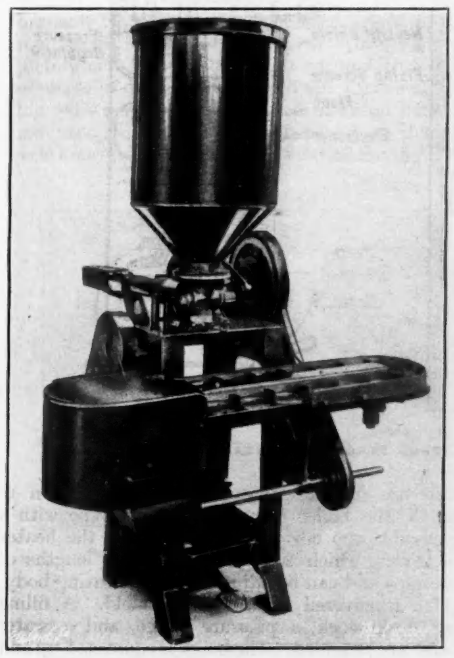


FIG 2—AUTOMATIC FILLING MACHINE

horizontal types, with single or double-acting propellers or blades. They are steam or water jacketed if required. The vertical types are mainly adapted for the mixing of pasty products, and are made from 5 to 100 gallons capacity. They are designed to allow the mixing elements to be easily removed, so that the pan may be used independently when desired. A machine of 20 gallons capacity requires 2 H.P. to drive the mixing blades. The horizontal machines are made for mixing powders, liquids, or pastes, and are fitted with twin propellers of double Z pattern. The drive for the propellers may be by electric motor or by belt and pulleys. When electric drive is adopted, the arrangement is very compact, as the motor is accommodated directly under the pan and does not increase the floor space occupied.

Fig. 2 illustrates a filling machine made by this firm, and will serve to indicate the compact design that has been found successful in practice for automatically filling tins, bottles, and collapsible tubes with a large variety of substances. The hopper containing the substance to be packed is mounted near the top of the machine. Its standard size holds 15 gallons and the pump attached has a maximum capacity of 1 lb., but can be adjusted for smaller quantities. When desired, both the hopper and pump can be made in Monel metal or Staybrite steel. The automatic feeding table is seen at the front of the machine, and the feed chain, carrying the adaptors in which are placed the containers to be filled, may be seen at the point where the guard is removed. The adaptors are made detachable, and can be changed when necessary to accommodate other sizes. In some cases the machines are supplied without the automatic feeding table, a platten or table taking its place to support the container while being filled, but in either case the containers are put on and taken off by hand. The machine is driven by a $\frac{1}{2}$ H.P. electric motor, and the output is thirty to sixty fills per minute, according to the weight taken by the container being charged.

Another filling machine, for dealing exclusively with liquids, is shown in Fig. 3. It will fill barrels either in a vertical or horizontal position. The filling valve seen immediately above the barrel is connected to the storage tanks by pipe line, and a telescopic nozzle fits into the bung hole to prevent the liquid splashing as it displaces the air in the barrel. In use the platform is let into the floor, so that barrels can be run on and off with ease. The quantity of liquid discharged into the barrel is governed by weight, and as soon as the correct quantity has been delivered, the flow is automatically stopped by closing the specially designed

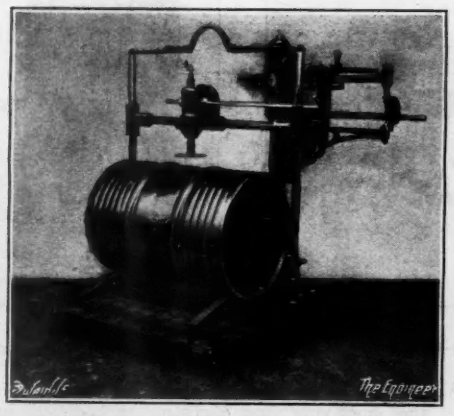


FIG. 3—LIQUID FILLING MACHINE

filling valve, this valve being actuated by a trip action governed by the movement of the beam when the predetermined weight of oil in the barrel is reached. The filling time varies according to the viscosity of the liquid being handled, but as an example, it takes only one minute to run 40 gallons of oil into a barrel when the viscosity is that of Double Shell at 70 deg. Fah. Smaller filling machines are made for dealing with paints and varnish and other similar liquids, which are usually sold in small cans or tins. The small machine shown in Fig. 4 operates in the same way as the bigger type, but the trip action for closing the filling valve is naturally more sensitive, and can be set to operate within a very narrow margin of dead accuracy. In all these machines the outlet edge of the filling valve is machined to a special angle to prevent drip. This may appear a small matter, but actually it is important, because on account of it the filling process is easily kept both clean and accurate, a feature that will be appreciated by all who are responsible for this side of the business.

An example of the firm's machines used for moulding wax and similar substances is shown in Fig. 5. This machine has been designed for the manufacture of candles on a large scale. It will mould 480 candles at one filling with the wick automatically inserted, and, as previously mentioned, it is capable of giving an output of 1440 finished candles per hour. The wax or whatever substance the candle is made of, is run in a liquid state into moulds in the top platen of the machine. An intermediate platen, which is elevated and lowered by means of a handle, carries pistons which serve to locate the wick and to eject the candle

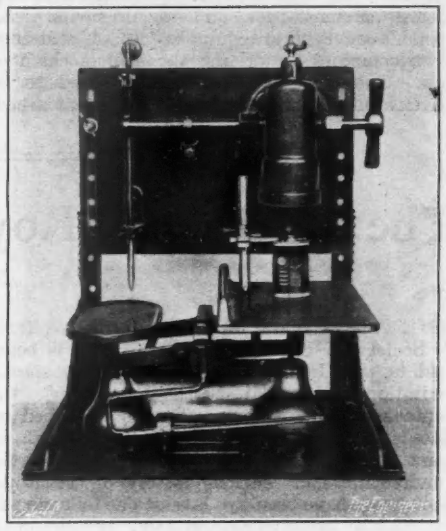


FIG. 4—SMALL LIQUID FILLING MACHINE

from the mould after the liquid has cooled and set. Spools of wick are carried on spindles, which are held central with the pistons and moulds, the spindles being fixed in the base of the machine. Two spools of wick are seen in the illustration standing on their respective spindles. There is, of course, a spindle and spool of wick, and also a piston for each mould on the machine, each spindle and piston standing in line and central with the particular mould they serve. For the purpose of quickly unloading the machine, special clamps have been designed and are supplied as part of the equipment with the machines. Two of these clamps can be seen in Fig. 5 standing on the top of the mould and already loaded with finished candles. When preparing the machine for work, the bottom spindles are first filled with spools of wick. One outer end of a wick is then threaded through each piston and up to the top of each

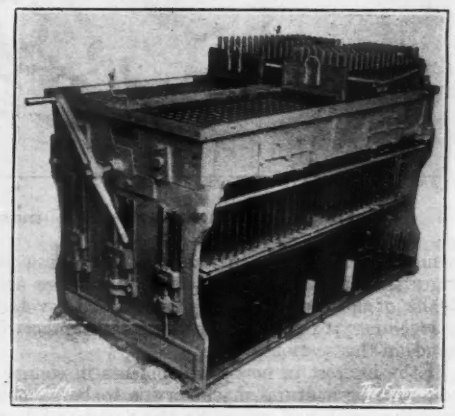


FIG. 5—CANDLE MOULDING MACHINE

mould, where it is secured in a central position. At this stage the platten carrying the pistons is in its lowest position, as shown in the figure. Wax is then run into the moulds until it reaches the top of the filling tray and when it is cool and set, the surplus wax is scraped off and the pistons are elevated with the platen by means of the end handle, and eject the whole lot of the candles from the moulds into the clamps, which have been placed on the top. The clamps are now closed by a simple end movement, which lock all the candles in a vertical position over the moulds. The pistons are now lowered again to the bottom position,

leaving the wick still attached to each candle and hanging centrally in the mould. Another filling is now applied, and when this is set, the wicks are severed by passing a knife between the top of the mould and the underside of the clamps. The machine is now unloaded by removing all the clamps filled with candles, and again replacing them, when empty, in position on the machine to receive the next batch, and the operations repeated. All this looks a very simple unskilled job of work, and so it is; but it is a well-thought-out job withal, and shows all the signs of the thoroughness usually associated with the planning of the skilled engineer.

Mention must also be made of various types of chain and belt conveyors made by this firm. Both fixed and portable conveyors are made in standard lengths of 12ft., or are specially designed to suit special circumstances and requirements. All portable conveyors are equipped with self-contained electric motors for driving the endless chain or belt. The fixed conveyors are adapted to be driven from the machine to which they are attached, but in cases where conditions do not permit of this, a motor can always be fitted.

Belt, chain, or platform conveyors are very much in evidence in many factories, particularly where continuous production is the rule. They are always great savers of labour, time, and space, but in some instances they actually control the rate of production by the speed at which they are set to convey work from one operation to another. In some of the light industries where it is usual to pack the product in cartons ready for despatch, the conveyor has become practically essential to well-ordered production, because of the great numbers of containers and cartons that have to be handled to keep pace with the product leaving the machines. For instance it is only necessary to witness the rate at which tubes and containers are filled and sealed on some of the machines just considered to realise the confusion that might easily arise if adequate means were not provided for carrying the packets clear before the machine became buried beneath its own output.

(To be continued)

The Centenary Royal Show at Windsor

No. I

THE Annual Show of the Royal Agricultural Society of England, which this year is being held in the Great Park at Windsor, by special invitation of His Majesty the King, marks the Centenary of the Society. The Show opened on Tuesday, July 4th, and will close to-morrow. In point of fact, however, this year's Show is not the hundredth, as in the long history of the Royal Show there have been two breaks, one following an outbreak of cattle disease in 1866, and the other during the last two years of the War. The Jubilee Show of the Society was also held at Windsor in 1889 under singularly happy circumstances, and was a brilliant success. There is no doubt that the present Centenary Show, with His Majesty the King as its Patron and President and the Earl of Athlone as Deputy President, will be no less a memorable occasion. In size, the 1939 Show is larger than those of recent years, and there are 4300ft. of shedding in the implement yard devoted to machinery exhibits, while the total number of stands in this section is 430.

If the interest in new developments in connection with agricultural machinery is to be gauged from the number of entries for the Society's Silver Medals for "New Implements for Agricultural or Estate Purposes," there is no lack of activity, for there are this year nine entries, which are representative of all sides of agricultural engineering. The judging of these exhibits is again in the able hands of Mr. Harold V. Blackstone, who is being assisted in his task by Mr. L. R. Bomford.

The Society's Silver Medals for new implements have been awarded to the Firestone Tyre and Rubber Company, Ltd., of Brentford, for a spade-grip tractor tyre; W. N. Nicholson and Son, Ltd., of Newark, for a combined swath-turner and side-rake; The General Electric Company, Ltd., of Kingsway, W.C., for an electric dairy sterilising chest; and Mr. W. M. Catchpole, of Stanton, Bury St. Edmunds, for a beet harvester. The Show is made exceptional by the inclusion of historical exhibits and displays to which we shall refer next week.

As in previous years we give in what follows short illustrated descriptions of some of the new implements and machines, together with some other items of engineering interest.

Bamfords, Ltd.

Few firms are exhibiting a wider range of farm machinery than that which is to be seen on the stand of Bamfords, Ltd., of Uttoxeter. It includes haymaking and food preparing machinery, as well as manure distributors and harrows for grass land. The firm is also showing a group of its own oil and petrol engines, along with pumps and saw benches. We have chosen for description and illustration by the engraving and drawing reproduced in Figs. 1 and 4 the firm's new light-draught "XLI" pattern potato digger, which incorporates some novel technical features for which patents are pending. As will be seen from the engravings, the design which has been adopted is a very neat one, incorporating an all-steel frame for the fork reel, which has six sets of digging tines mounted on an inclined shaft. These tines, it will be noted, project downward and their points are curved away from the direction of rotation of the digger. The result is that they lift the crop gently and it is claimed that no bruising takes place. In order to remove the haulms, picker bars are also fitted on the periphery of the fork reel. The share, which is rigidly attached to the machine, raises the ridge and the fork reel, which is placed immediately behind it, gently sweeps the crop of potatoes on to the side reel. This acts as a sieve and removes the earth from the potatoes, which are deposited by the reel in even rows on the ground, ready for picking.

It may be noted that the bevel wheels which drive the reels are completely enclosed in dust-proof casings, the castings which form the covers acting as grease boxes, so that the gears are kept clean and are well lubricated. The ratchets are also enclosed in similar dustproof casings. In order to accommodate the machine to differing widths of rows adjustable road wheels have been provided. In addition to the new light-draught machine we have described the firm is also showing its well-known "Triumph" potato digger.

The General Electric Company, Ltd.

As in previous years, The General Electric Company is well represented at the Show. Apart from its usual stand, it has supplied the equipment for the electric farm and a considerable amount of heavy cooking equipment for the restaurant services connected with the Show. We also noted one of the new G.E.C. floating electrode boilers, referred to later, on the stand of the Alfa-Laval Company, Ltd., where it provides the sterilising and hot water service connected with that firm's milking exhibit.

The main attraction on the G.E.C. stand itself is the 27ft. dairy sterilising chest—Fig. 5—which was entered in the class for the R.A.S.E. silver medal and has gained that award. It embodies in its design several new features which have been introduced following many years of experience of the service requirements of dairy sterilising plant. Quick steaming within a few minutes of switching on the current is ensured. Not only can utensils and bottles be sterilised in the cabinet, but, in addition, as will be seen from our illustration, a pressure steam jet is available for treating the churn stool, milking machine rubbers, milk pipe lines, &c., while hot water is available at any time when steaming is not in progress. A wide door has been adopted, which gives easy access to all parts of the chest from the front. The steam and hot water lever control is at the front of the chest, and an automatic water feed guards against possible burning out of electrodes. Particular care is taken to provide rust-free parts, and all the parts are carefully galvanised after they have been made and assembled.

Another item of interest is the floating electrode steam raiser, which, we are informed, is finding a wide use in the dairy industry. As shown in Fig. 3, the boiler is of the vertical type with a removable top cover, giving access to the heater electrodes, which are formed by short lengths of iron pipe and can be adjusted in the floating body, which is covered by a neutral shield. A filling and drain cock, a pressure gauge, and a water gauge are provided. The boiler is connected up and the position of the floating electrodes is so adjusted that the current taken is about 90 per cent. of the desired maximum when the water boils. Should this not be possible with some kinds of water with the electrodes fully immersed, then the addition of a small amount of salt to the water will bring about the desired result. With the boiler filled with water to within 2in. of the top of the water gauge it will operate for about one to one and a-half hours without refilling. Other exhibits include a display of dairy equipment by Coldair, Ltd., an associated G.E.C. company, and various patterns of motors designed for farm work. On the horticultural side, in connection with a Crittall all-metal greenhouse, the G.E.C. is demonstrating

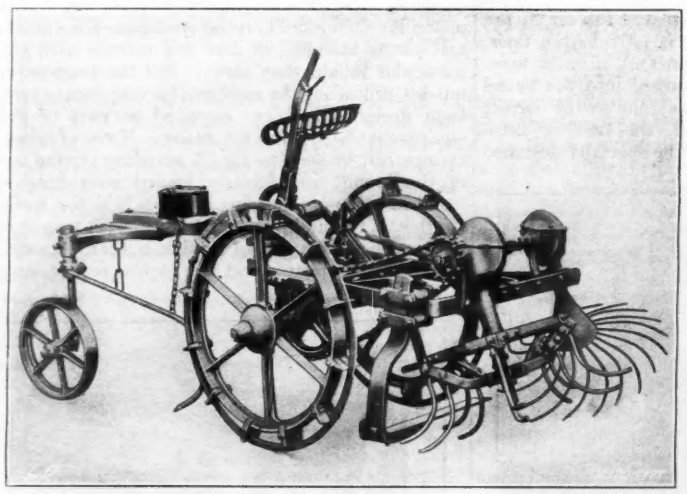
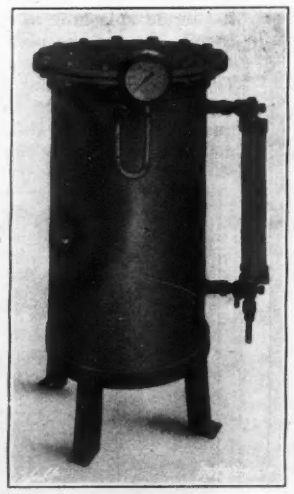


FIG. 1—LIGHT-DRAUGHT POTATO DIGGER—BAMFORD



FIGS. 2 AND 3—FLOATING ELECTRODE STEAM BOILER—G.E.C.

thermostatically controlled greenhouse heating, plant irradiation, and soil heating cables.

FORD MOTOR COMPANY, LTD.

The Fordson tractor made by the Ford Motor Company, Ltd., of Dagenham, Essex, has long been an important unit among British-produced tractors. This year, in addition to the agricultural tractors, and those of the land utility type fitted with either Dunlop, Goodyear, or Firestone tyres, the front wheels. If desired, a single front wheel can be fitted. The pneumatic tyre is 9·00 by 10, or dual cast wheels 24in. diameter can be fitted. The rear wheels are fitted with 9·00 by 36 pneumatic tyres, or with steel wheels having a rim diameter of 50in., with spade lugs offset. The principal dimensions of this new tractor are :—Wheel base, 83·7in.; overall length, steel wheels 126·7in., pneumatic 125in.; overall height, with steel wheels 63·75in. and with pneumatic wheels

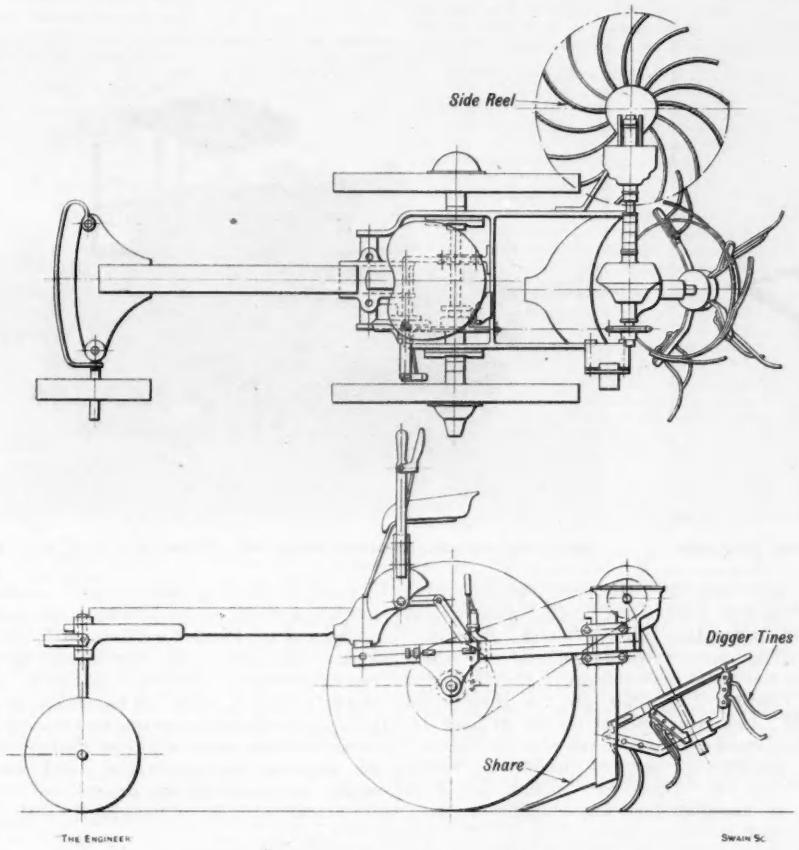


FIG. 4—POTATO DIGGER—BAMFORD

there is shown the new Row crop tractor which we illustrate on page 14. It embodies in its design the standard Fordson power unit and transmission, but new features are the increased height to clear row crops, easily adjusted rear wheels, a completely new front wheel construction with a choice of single or double wheels, and a new type of steering with a worm gear enclosed in an oil bath and mounted on Timken roller bearings in the front axle housing. This housing, as our engraving shows, 62in. The rear wheels can be rapidly adjusted to suit the width of any normal row crop, and the inside minimum distance between the rear wheel spade lugs is 45in., while the inside maximum distance between the rear wheel spade lugs is 74½in. The standard speeds with special ratio transmission and 50in. steel wheels is low gear 1·85, intermediate 2·78, high 4·90, and reverse 1·40 m.p.h.

Models of this tractor fitted with various types

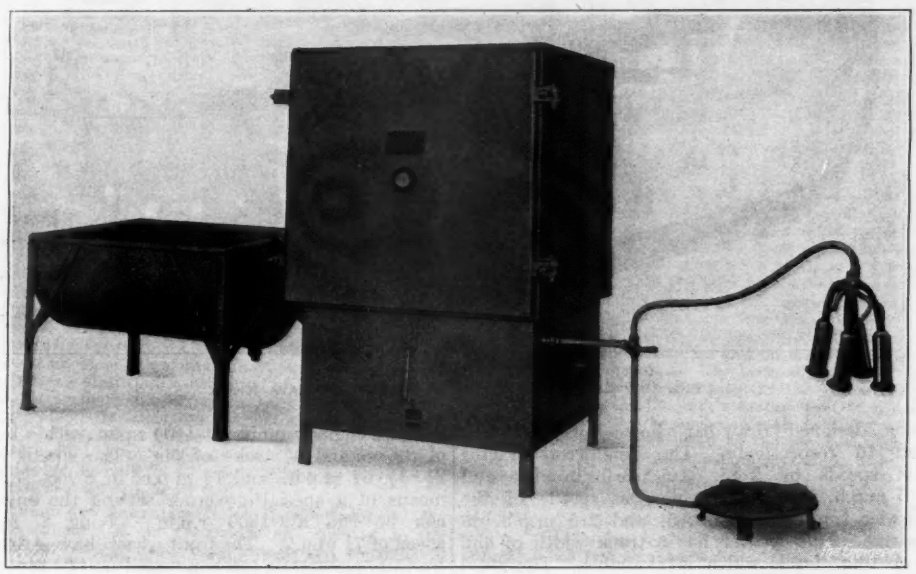


FIG. 5—STERILISING CHEST—G.E.C.

is a steel forging, and it, too, is mounted on Timken bearings which can be adjusted for wear. There is a flanged base with a spigot, which carries the front wheel hubs. These can be steel or pneumatic tyred, and the two wheels are inclined slightly towards each other inwards, so as to give better steering by imparting a trailing effect to of wheels are on view, also tractors specially designed for golf course work.

DAVID BROWN TRACTORS, LTD.

Another new British tractor is that shown for the first time by David Brown Tractors, Ltd., of Huddersfield. We may recall that in an article published in our issue of December 30th, 1938, we described the well-laid-out works in which this tractor is built and assembled. The appearance of the new tractor is different from that of the Ferguson-Brown tractor which was exhibited at last year's Royal Show. The pleasing appearance of the new machine may be judged from our engraving on page 14. Particularly noticeable is the uninterrupted understructure, which is useful in case of row crops, and discourages any accumulation of dirt. The chassis is of box section, and into it all the component parts which are built as a sub-assembly, are fitted. This, it is claimed, gives a degree of accessibility greater than that

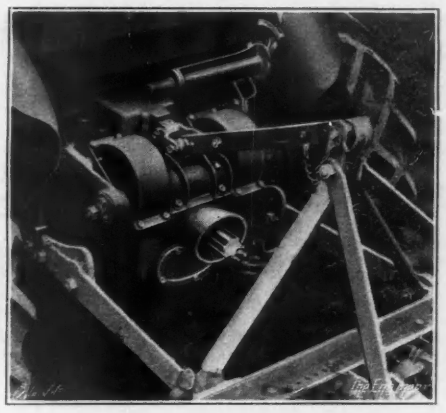


FIG. 6—HYDRAULIC REAR ATTACHMENT UNIT—DAVID BROWN

previously possible, and by means of hinged side doors all parts of the tractor are easy of access for inspection. We noted in particular the good view of the crop and implement which is to be obtained from the seat of the tractor, and the free leg room given. An interesting improvement is the provision of a special control lever near the back of the tractor, which allows the driver to inch-up when hitching up the tractor and the implement. As will be seen from the accompanying engravings (Figs. 6 and 7) there are two patterns of rear attachment. For ordinary implements a simple draw-bar of geometrical design is available, but if the hydraulic unit associated with Ferguson-Brown implements is preferred, it can be attached

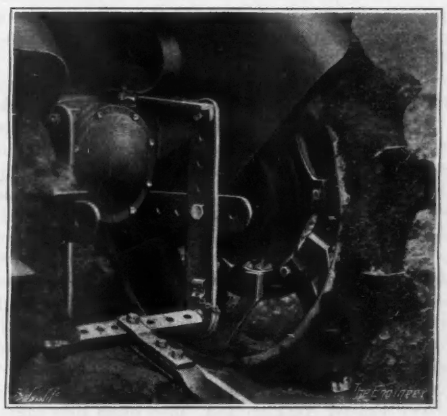


FIG. 7—GEOMETRIC ADJUSTABLE DRAWBAR —DAVID BROWN

to the rear axle drive, and operated by the power take-off extension.

The principal dimensions of the new tractor are as follows :—Length, 101in.; width, 58½in.; wheel base, 64in.; and ground clearance, 16in.; while the complete weight is less than 25 cwt. The small design allows the tractor to be employed usefully in orchards and hop gardens, and for this reason the turning circle has been kept down to 8ft. 6in. The engine is generally similar in design to the Ferguson-Brown tractor; it is a four-cylinder unit with a 3½in. bore and a 4in. stroke. The designed output is 25 B.H.P and 17 draw-bar horse-power. For road work an alternative governor setting is provided, giving a belt power of 33 B.H.P., with a road speed of nearly 20 m.p.h. The wheels are of special interest, as they are fitted with a common centre, which allows either rims for pneumatic tyres or steel wheels with spuds or a spud ring to be fitted. The governed road speeds are 2·2, 3·2, 4·5, and 9·5 m.p.h., with a reverse speed of 1·6 m.p.h. The power take-off, which projects from the rear axle casing and is centrally disposed, has a speed of

555 r.p.m. Together with the new "David Brown" tractor we have described, the firm is continuing to manufacture the Ferguson-Brown unit with its associated implements, thereby increasing the range of tractors and implements offered by the firm.

WALLIS AND STEEVENS, LTD.

One of the largest oil-engined road rollers shown at Windsor is that on the stand of Wallis and Steevens, Ltd., of Basingstoke. It is the 8-ton model—Fig. 9—of the firm's "Advance" series, and the engine fitted is a high-speed "National" working on the four-stroke cycle with direct injection. The three cylinders have a bore of 4½in. with a stroke of 6in., and with a swept volume of 3950 c.c. the designed output is 28 B.H.P. when running at 1050 r.p.m. The power from the engine is transmitted through a simple primary selecting clutch to a four-speed gear-box giving forward and reverse speeds corresponding to road speeds of 4, 2¼, 1½, and ⅞ miles per hour. The intermediate gears and the four-pinion differential gear are all machine cut and are totally enclosed, running in an oil bath, the final drive being by spur gear to both rear rolls. The rear axle is of the firm's patented automatic cambering pattern, and provision is also made to hold the rolls parallel or at any desired inclination by locking the axles. The rear rolls have a diameter of 4ft. 6in. with a width of 2ft., while the front roll has a diameter of 3ft. 9in. and is in two sections, each 1ft. 6in. wide.

The forecarriage, as will be seen from our engraving, is of an improved underslung pattern, which is designed so as to allow the front wheels to adapt themselves freely to the contour of the ground without transmitting any rocking motion to the chassis of the roller itself. This arrangement, it is claimed, produces much steadier rolling effect than does the overhead pivoted type. The steering is effected by a conveniently placed hand wheel which operates the steering pivot on the roller fork through an overhead reducing gear with a worm and segment. As will be gathered from our engraving, the frame of the roller is of heavy braced construction, with deep side plates. The design is such that ready access is given to both the engine and the transmission for running attention. Two brakes, a foot brake of the band type and a hand brake of the screw-operated type, with shoes acting directly on the inside of the rims of both driving rolls, are provided. The controls are neatly grouped in front of the driver. The fuel tank provides a supply of 30 gallons, which is sufficient for approximately thirteen to fifteen days on normal work. There is also provision made for towing and the attachment of a scarifier.

Another exhibit which we illustrate in Fig. 8 is a direct hand-spraying machine for cold emulsions, in which the drum or barrel of emulsion can be placed directly on the sprayer carriage, the suction pipe inserted and the fluid sprayed direct from the drum. There are two wheels which can be either steel or pneumatic tyred, with a diameter of about 18in. and a width of 3½in. on the face, giving, it is claimed, easy running and no sinkage. The wheels are carried on a swinging axle which gives a balanced load, whether the drum be full or empty. When the pump is being operated there is a steady foundation formed by the two wheels and the two struts at the end of the carriage. The pump is of the direct-acting type, with ball valves and a large-sized air chamber, along with a strainer which keeps the pump fully primed when the spraying is intermittent.

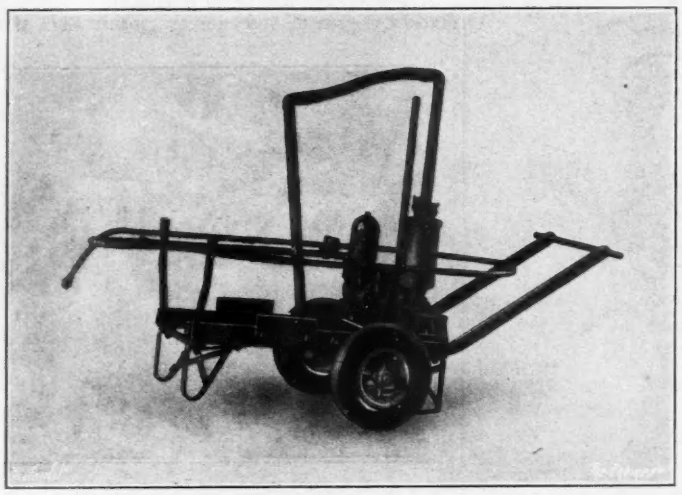


FIG. 8—HAND SPRAYER FOR COLD EMULSIONS—WALLIS AND STEEVENS

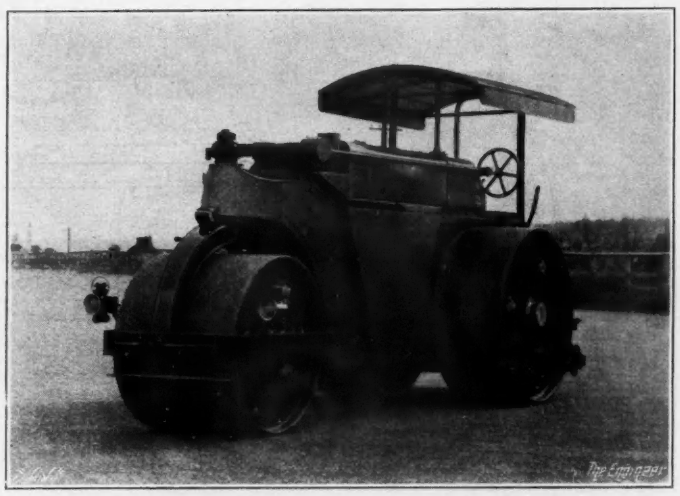


FIG. 9—8-TON OIL-ENGINED ROAD ROLLER—WALLIS AND STEEVENS

BLAW-KNOX, LTD.

On the stand of Blaw-Knox, Ltd., of Clifton House, Euston Road, N.W.1, there is on view a complete range of "Cletrac" crawler tractors ranging from 61 to 12 draw-bar horse-power. The two larger sizes of tractor are designed for heavy oil fuel, and the others for standard tractor paraffin vaporising oil. The firm is also showing various types of Blaw-Knox "G.B." light-weight pumps, including the "Midget" and "Bantam" models. The two new tractors of this year which represent the latest productions of the Cleveland Tractor Company, of Ohio, are the three-wheel "General" row crop tractor, shown on page 14, and the small "H.G." pattern "Cletrac" crawler tractor, a view of which we reproduce in Fig. 10. These new models are both fitted with paraffin fuel four-cylinder engines, with designed draw-bar horse-powers of 12 and 16 respectively. The row crop tractor has speeds of 2·25, 3·5, 6·0 m.p.h., and 2·5 m.p.h. in reverse, while the speeds of the crawler tractor are 2, 3, 5, and 2·5 m.p.h. in reverse. This tractor has a track width of 6in. and 10in. track width is available. The total length of track on the ground is 50in., corresponding to a total area of ground contact of 600 square inches. On the row crop tractor the rear driving tyres are 9in. by 24in., and the front tyres, of the guide ring pattern are 5·50in. by 16in. A working pressure of 28 lb. is recommended or 12 lb. minimum and 14 lb. on the furrow tyre when ploughing. The row crop tractor has a length of 118in. overall and its width can be varied from 64in. to 85in., while the crawler type tractor is 91in. overall with a width of 52½in.

JACK OLDING AND CO., LTD.

The firm of Jack Olding and Co., Ltd., which specialises in the distribution of American-made agricultural tractors, earth moving equipment, and roadmaking machinery, and which has recently moved into its new works at Hatfield, Herts, is showing at Windsor a full range of Caterpillar tractors, as well as some of the smaller earth moving equipment which we described in our recent special supplement on Plant for Work on Harbours and Docks. The firm is also displaying for the first time a full range of the new John Deere "H" type tractor, a view of which we reproduce on page 14. It is a particularly interesting design and has been constructed for two-row furrow plough work, two-row planting and cultivating, and handling a variety of power-driven, drawn and belt take-off machines. It is equipped with a twin-

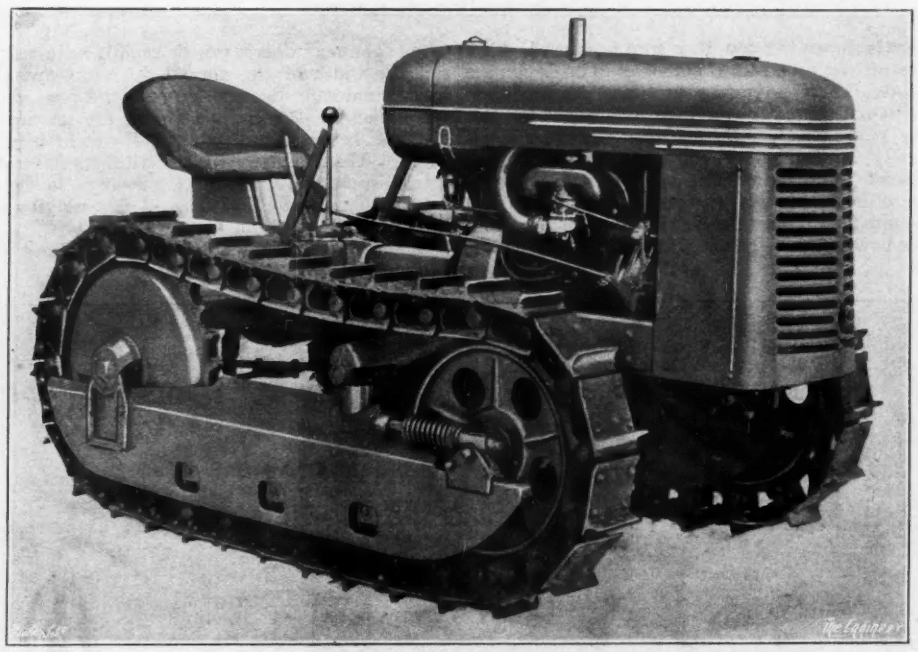


FIG. 10—"CLETRAC" CRAWLER TRACTOR—BLAW-KNOX

cylinder engine running at 1400 r.p.m. with a bore of 3 9/16in. and a stroke of 5in. The speeds are 2½, 3½, 5¾ m.p.h., and 1¾ m.p.h. in reverse. By means of a special governor setting the engine can be run at 1800 r.p.m., giving a road speed of 7½ m.p.h. The front wheels have 4·00in. by 15in. pneumatic tyres mounted on two tapered roller and two roller bearings. The rear wheels are fitted with 6·50in. by 32in. pneumatic tyres, but 7·50in. by 32in. tyres are available. The track of the rear wheels can be varied from 44in. to 80in. and the wheel base of the tractor is 76in. with a turning radius of 7ft. 5in. The speed of the power take-off is 546 r.p.m. The overall length of the tractor is 111¼in. and the overall width 75in.

(To be continued)

Rail and Road

L.M.S. STATION CLOSED.—The London Midland and Scottish Railway Company's stations at Garston (Church Road) and Northampton (St. John's Street) have been closed.

TRANSPORT IN CARDIFF.—The Cardiff Transport Committee has received a report from its Transport Manager stating that it is hoped that the change over from trams to trolleybuses in the city will be completed in eighteen months at a cost of £277,497.

ITALIAN RAILWAY ACCIDENT.—It is reported that a recently inaugurated express train running between Milan and the Bremner Pass ran into a stationary goods train at Lambrate Station on Sunday, July 2nd, and three persons were killed and about fifty injured.

L.M.S. SCOTTISH COMMITTEE.—In place of Mr. J. Whiteford Murray, who has retired, the directors of the London Midland and Scottish Railway Company have appointed Captain Sir Ian Frederick Cheney Bolton, of West Plean, Stirling, a member of the company's Scottish Committee.

ROAD AND RAIL TRANSPORT.—During the next session of Parliament a Bill will be introduced to give effect to the recommendations of the Transport Advisory Council on the "square deal" proposals of the main line railways. A Central Conference representing the two interests has begun the task of co-ordinating rail and road goods transport.

INDIAN RAILWAY ACCIDENT.—When an express train from Delhi to Dekra Dun left the rails near Moradabad early in the morning of June 28th last, ten people are reported to have been killed and twenty-one injured. It is stated that the bank near a culvert subsided as a result of heavy rains, and the engine and three coaches fell into the breach.

LEVEL CROSSINGS.—The Minister of Transport was recently asked in the House of Commons how many level crossings had been abolished in this country during the past five years. He replied that since April 1st, 1934, thirty-seven level crossings have been eliminated or avoided. In twenty other cases works are in progress and thirty-two further schemes are at present under consideration.

SOUTHERN RAILWAY ELECTRIC STOCK.—The Southern Railway Company at present owns 3189 electric passenger vehicles, according to Mr. A. Raworth in *Modern Transport*. Of these vehicles, 2586 are designed for a maximum speed of 60 m.p.h., and the remainder for 75 m.p.h. It is pointed out that in the first batch of 336 motors of the former type, which have been in continuous service since 1915, only five armatures have been rewound.

NEW BLAST PIPE CAPS ON S.R. LOCOMOTIVES.—The "Lord Nelson" class engines of the Southern Railway Company are being fitted with blast pipe caps with five 2⅝in. diameter nozzles discharging into a chimney 2ft. 1in. diameter at the choke. The five small nozzles have a 13 per cent. greater cross-sectional area than the original single blast pipe tips with a 5½in. diameter orifice discharging into a chimney 1ft. 3in. diameter at the choke.

ELECTRIC RAILWAYS IN SWEDEN.—The length of electrified lines in Sweden totals about 3700 kiloms., or half of the Swedish State Railways system. These lines handle about 85 per cent. of the country's total rail traffic, according to Mr. I. Overholm, and had resulted in an increase in the speed of passenger trains by up to 30 per cent. and electrically hauled goods traffic up to 50 per cent. He points out that between 1931 and 1938 about £10 millions was spent on electrification, and the schemes in hand involved an expenditure of over £4 millions.

LONDON MIDLAND AND SCOTTISH RAILWAY.—The fourth annual presentation of shields to the winning districts in the London Midland and Scottish Railway Company's Motive Power League (for the reduction of engine casualties) was held at the Euston Hotel on June 28th, when Mr. T. W. Royle, the chief operating manager, said that several records had been attained during 1938. The past year had produced the highest miles per casualty figure, and in the last four weeks the debitable engine casualties only amounted to 202, the lowest on record. Mr. D. C. Urie, superintendent of motive power, drew attention to the fact that out of between 80,000 and 90,000 locomotive axle bearings in use every day, only seven per day gave trouble by overheating.

A LIGHT ALLOY ROAD TANKER.—A new road tanker recently completed for the Northern Aluminium Company, Ltd., provides a good example of the saving which can be effected by light alloy construction. Built on an Albion chassis by W. P. Butterfield, Ltd., of Shipley, Yorks, the tanker has a capacity of 1200 gallons with unladen weight of 2 tons 9 cwt., which allows a speed of 30 m.p.h. The sheet with which the tank is constructed is a 1¼ per cent. manganese aluminium alloy, and is gas welded. The tension straps are constructed of a similar material, and the castings supporting the tank are also of lightweight alloy. It is pointed out that a welded steel tank on a similar chassis falling within the 50 cwt. category would have a capacity of between 900 and 1000 gallons; the use of aluminium therefore allows an increase in carrying capacity of 20 per cent.

CAMBRIDGE ARTERIAL ROAD IMPROVEMENTS.—The traffic capacity of the Cambridge arterial road on the 2-mile section between Bury Street and Carterhatch Lane, Middlesex, will be more than doubled in the course of the next eighteen months by the building of a second carriageway and the widening of the existing one. In addition, cycle tracks and footpaths will be provided. The new carriageway will be 27ft. wide and the width of the old one, now 24ft., will be increased accordingly. Included in the scheme is the widening of the bridge over the London and North-Eastern Railway. This is at present 60ft. and is to be widened to 100ft. The proposed improvement, which will cost about £100,000, is part of a general scheme for duplicating the existing carriageway and the lay-out is similar to that already adopted on the section between Lordship Lane and the North Circular Road.

Miscellanea

WELSH TIN-PLATE INDUSTRY.—In the course of his presidential address to the Swansea Exchange, Sir William Firth said that the order books of the sheet and tin-plate industry indicated that plants would be operating near to capacity well into the autumn, but the future remained somewhat obscure. He believed that amalgamation in the sheet and tin-plate trade of this country was urgently necessary in the interests of shareholders and workpeople alike. In times of poor demand it was surely better to operate sufficient plant fully and so make possible a lower selling price than to operate efficient and inefficient plant partially and so increase costs and selling price.

ANODICALLY OXIDISED ALUMINIUM ALLOYS.—An article in *Metals and Alloys* deals with the effects of electrolytic oxidation on the colour and uniformity of appearance of anodic coatings on aluminium alloys containing a variety of constituents. Several methods of metallographic examination show that the size and distribution of the micro-constituents may have important effects on the oxidation characteristics. It is shown that the tendency of some anodically oxidised aluminium alloy samples to develop a streaked appearance during treatment is influenced by the size, amount, distribution, and oxidation characteristics of the micro-constituents.

SOCIETE DES INGENIEURS CIVILS DE FRANCE.—At a meeting held in Paris on Friday, June 30th, the President of the Société des Ingénieurs Civils de France, Monsieur Raymond Berr, presented the Gold Medal of the Société (Prix Annuel) to Mr. W. T. Halcrow, for his paper entitled "Tapping a Lake at 32 m. Below the Surface," read before the Société in Paris on May 27th, 1938. This is the first occasion on which the premier prize medal of the Société has been presented to a British subject since its award was instituted in 1861. Mr. Halcrow, who is the President of the British Section of the Société, described in his paper the Ben Nevis tunnel, through which water from Loch Treig is delivered to the British Aluminium Company's power station at Fort William.

ELECTRICITY IN MINES.—In the House of Commons recently, the Secretary of Mines was asked to state the number of explosions in coal mines attributable to the use of electricity in Scotland and England and Wales, respectively, during the last ten years; and whether, in view of the danger involved, any consideration had been given to the possibility of abolishing this form of haulage. He replied that in Scotland thirteen explosions were due to electricity out of 246 explosions from all causes, and in England and Wales twenty were due to electricity out of 214 from all causes. The use of electricity for haulage purposes was only one of many uses to which electricity was put. The subject had been considered in all its aspects by the Royal Commission on Safety in Coal Mines.

AIR RAID SHELTER DESIGN.—The award of the assessors has now been made in the competition recently held by the Air Raid Protection Institute, at the suggestion of the Lord Privy Seal, for the design of an above-ground air raid shelter for fifty persons, providing protection against blast, splinters, and light incendiary bombs. The premium of 100 guineas has been awarded to the design, octagonal in plan and carried out in monolithic reinforced concrete, submitted jointly by Mr. G. Kilner and Mr. Clifford Smith, of 173, Kingston Road, New Malden, Surrey. The designs submitted in the competition will be on exhibition at the headquarters of the Air Raid Protection Institute, 2, Millbank House, Wood Street, S.W.1, from Monday, July 10th, to Saturday, July 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.—The annual conversazione of the Institution of Electrical Engineers was held on Tuesday last, July 4th, at the Natural History Museum, South Kensington. Members and guests—who seemed to be more numerous than ever—were received by Dr. A. P. M. Fleming, President; Mrs. Morris Fleming, and the Council of the Institution. For those with musical tastes, excellent fare was provided in the form of a concert by the string band of the Royal Artillery, and an alternative concert at which the artists were Miss Olive Groves, Mr. Dennis Noble, Mr. Arthur Catterall, and Mr. William Murdoch. As usual, the occasion provided many opportunities of renewing acquaintanceships and maintaining friendships. By arrangement with the museum authorities, many of the halls were open to inspection.

INDUSTRIAL AIR RAID PRECAUTION ORGANISATION.—The Civil Defence Bill, which is now before Parliament provides that all industrial and commercial undertakings which employ more than thirty persons shall ensure that all their employees know what to do in the event of an air raid, and that the personnel necessary for first aid, anti-gas measures, and for fire fighting, is trained and equipped. A preliminary memorandum on the "Organisation of Air Raid Precautions Services in Industrial, &c., Undertakings, and on the Training and Equipment of Personnel," has been prepared by the Air Raid Precautions Department of the Home Office, and published by his Majesty's Stationery Office, price 3d. It outlines the organisation and facilities which will be required to give effect to the provisions of the Civil Defence Bill in industrial undertakings, including commercial office buildings.

SURFACE WATER RESOURCES OF BRITAIN.—Prepared under the direction of the Inland Water Survey Committee, "The Surface Water Year Book of Great Britain, 1936–37," has just been published. It is the second of the series to be issued, and comprises a statistical report relating to the twelve-month period ended September 30th, 1937. It covers considerably more ground than the earlier volume. The measurements of which statistics are given relate to sixty-eight gauging stations in twenty-two river basins as compared with twenty-eight gauging stations in fourteen river basins in 1935–36. The new items have been supplied mainly by water undertakings, but they also include particulars in respect of the River Lee and the Warwickshire Avon supplied by the relative Catchment Boards, and of Lake Windermere furnished by the Freshwater Biological Association. The Year Book provides details of the run-off of each area and its rainfall.

Air and Water

THE IMPERIAL SHIPPING COMMITTEE.—Sir Halford Mackinder has resigned from the position of chairman to the Imperial Shipping Committee and has been succeeded by Sir William Clark.

NEW GERMAN CRUISER.—The fifth new German 10,000-ton cruiser "Lützow" was launched at Bremen on Saturday, July 1st. This ship will have a speed of 32 knots and be very heavily armed.

ANOTHER GLIDER RECORD FLIGHT.—On Saturday, July 1st, a new altitude gliding record was set up by Mr. P. A. Wills in a German-built Wolf-Hirth machine. He reached a height of 14,200ft.

NEW BATTLESHIP LAID DOWN.—On Tuesday, July 4th, the keel of the new 35,000-ton battleship "Lion" was laid at the berth at Vickers-Armstrongs Naval Yard at Barrow-in-Furness, from which H.M.S. "King George V" was launched.

SALTED RUNWAYS IN CANADIAN AIRPORTS.—As a result of the successful use of a mixture of salt and clay as a stabiliser for the foundation of highways and as a veneer for gravel roads, runways at a number of Canadian airports are being made by this method.

LONDON'S SHIPPING.—During the week ended June 23rd, 1073 vessels, representing 1,102,247 net register tons, used the Port of London. Of these 571 vessels, (896,420 net register tons) were to and from Empire and foreign ports and 502 vessels (205,827 net register tons) were engaged in coastwise traffic.

NEW DUTCH MOTOR LINER.—During her recent trials the new motor liner "Oranje," of the Netherland Steamship Company, reached a speed of 26·3 knots. She has three screws, each of which is directly coupled to a single. acting, two-stroke, airless injection oil engine capable of developing 12,500 H.P. at 145 r.p.m.

R.A.F.V.R. AND AERODROME SITES.—The smallness of the aerodrome accommodation near London has made it necessary for the Air Ministry to increase the number of aerodromes for the training of the Royal Air Force Volunteer Reserve. The Ministry is now considering a number of sites suitable for the construction of aerodromes.

NATIONAL GLIDING CONTESTS.—Twelve different types of sailplanes are included in the twenty-eight entries which have been received for the National Gliding Contests to be held at Camphill, Derbyshire, from July 8th to 16th. The entries include eight types of British design and construction, and one of foreign design built in this country.

A HIGH-SPEED FIGHTER.—It is reported that in official trials, with standard service equipment, a Vickers Supermarine "Spitfire" fighter recently reached a speed of 367 m.p.h. in level flight at Martlesham Heath. The machine was fitted with a variable pitch airscrew and the above speed was reached at a height of 18,400ft. Its top level speed at 18,500ft. with a fixed pitch airscrew is given as 362 m.p.h.

LLOYD'S REGISTER OF SHIPPING AMERICAN COMMITTEE.—It is announced that Mr. L. H. Korndorff, president of the Federal Shipbuilding and Dry Dock Company, Kearny, New Jersey, has been elected chairman of the American Committee of Lloyd's Register of Shipping. Mr. C. D. Mallory, president of the C. D. Mallory Corporation and associated companies, has been elected deputy chairman.

BRITISH OIL-FIRED STEAM TRAWLER.—The "Akita," the first oil-fired steam trawler to be built and owned in this country, has been completed by Cochrane and Sons, Ltd., for Neale and West, Ltd. She is 127ft. 6in. long by 24ft. 8in. beam and has a mean draught of 10ft. 8in. Her 625 I.H.P. triple-expansion engines have cylinders 13in., 22½in., and 37in. diameter by 26in. stroke, the working pressure being 200 lb. per square inch. During her trials an average speed of 10·5 knots was attained.

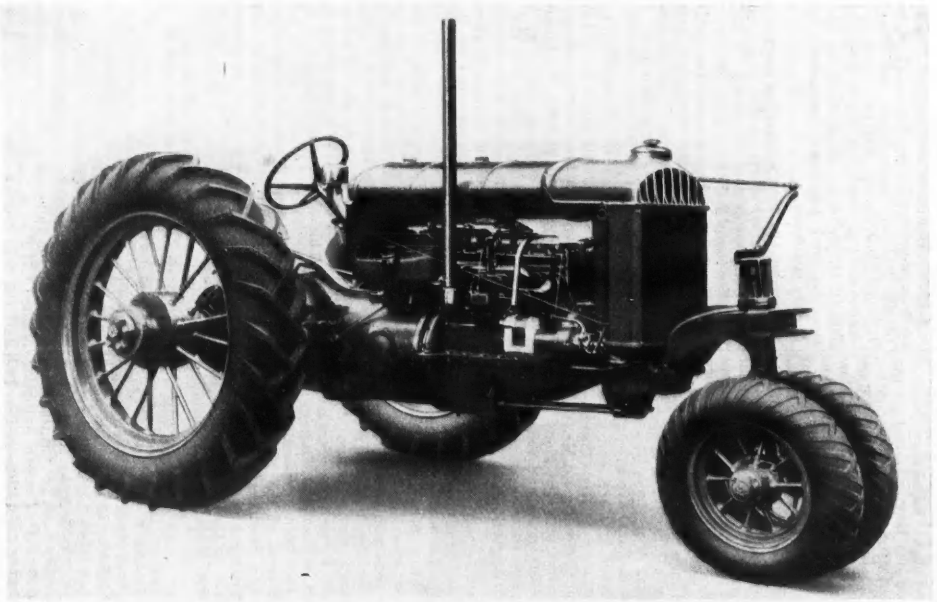
LLOYD'S REGISTER OF SHIPPING.—On Tuesday, July 4th, the Chairman and Committee of Lloyd's Register of Shipping gave a luncheon at the offices of the Society to the Lord Mayor and Sheriffs of London. Many representatives of the shipping industry, the shipbuilding industry, the Defence Services and the Board of Trade were present, and the guests were received by Sir George Higgins, the Chairman of Lloyd's Register, Mr. Ernest L. Jacobs, the Deputy Chairman, and Mr. R. M. K. Turnbull, the Chairman of Classification.

BELGIAN AIR LINES.—According to the new time table of the S.A.B.E.N.A., which has just been issued, convenient air service to Brussels and Frankfort is provided by the "Vienna Air Rapide," which leaves Croydon at 8.45, arriving in Brussels at 10, after a seventy-five minutes' flight. Frankfort is reached at 11.30, and Vienna at 14.50. This service is maintained by 21-seater Douglas "D.C.3" air liners. Another service leaves Croydon at 14.00 and arrives at Vienna at 21.45. In connection with the International Water Exhibition at Liège, all passengers arriving by air in Brussels, if in possession of Belgian tourist vouchers, are entitled to a free rail pass, second-class, from Brussels to Liège. New services to Ostend and Le Zoute have begun and will be supplemented by new services on Fridays, Saturdays, and Mondays, from July 14th.

NEW DUTCH LINER'S ENGINE.—A new 2687-ton liner, "Batavier III," has been placed in the Rotterdam–London service of the Batavier Line. This vessel is propelled by an interesting Werkspoor three-cylinder compound engine, having hydraulically operated Mier-Mattern type valve gear. Its normal output at 125 r.p.m. is 3000 I.H.P., the high-pressure cylinder being 650 mm. and the two low-pressure cylinders 1000 mm. diameter by 1000 mm. stroke. The three cylinders are separate castings assembled into a longitudinal girder by bolting the receiver passages together. Each cylinder has separate inlet and exhaust valves of the double-beat poppet type. The hydraulic valve gear is operated by oil led through pipes from pumps operating directly from the engine. Each valve has one pump, and engine control is effected by turning the pump pistons through an angle to adjust the oil pressure.

TRACTORS AT THE CENTENARY ROYAL SHOW AT WINDSOR

(*For description see page 10*)



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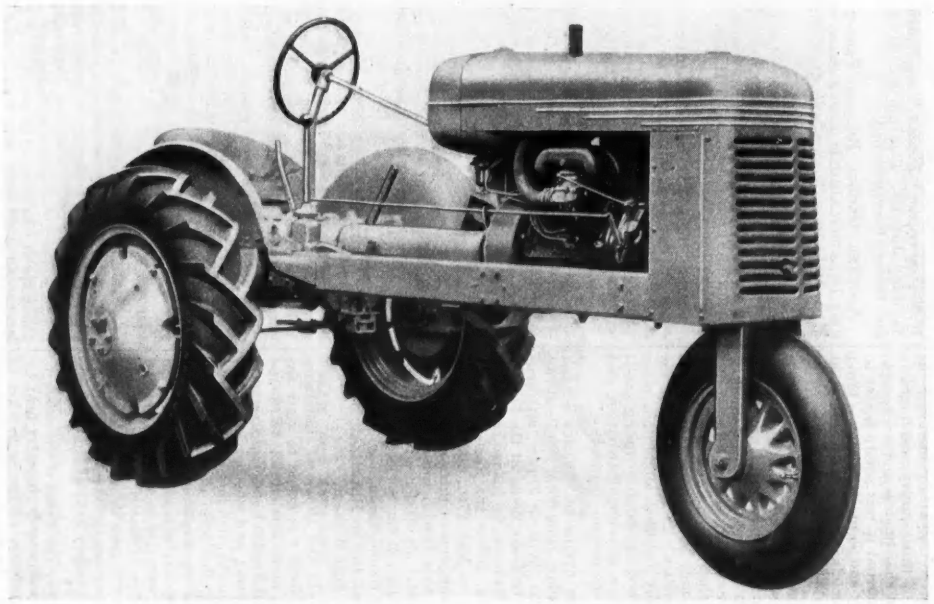

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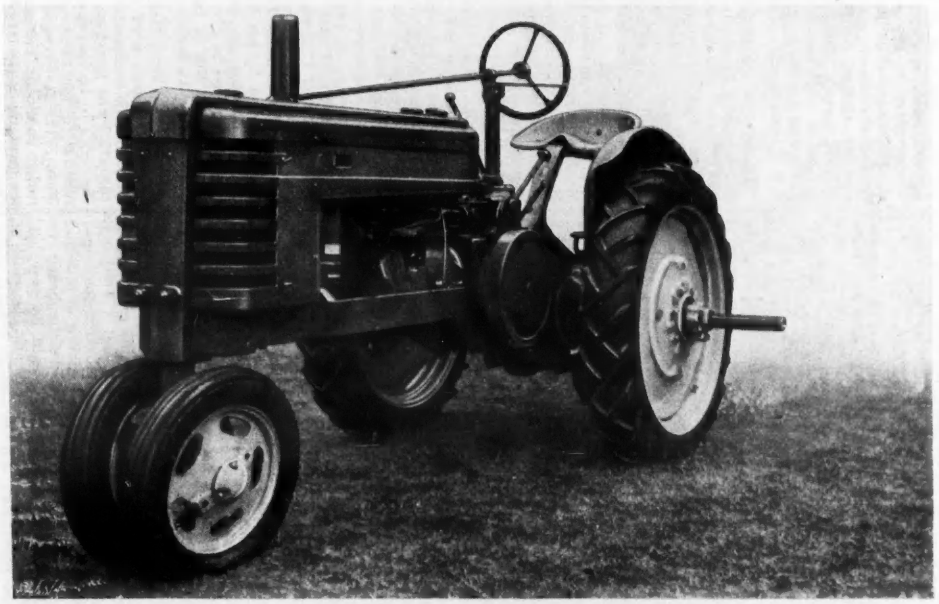
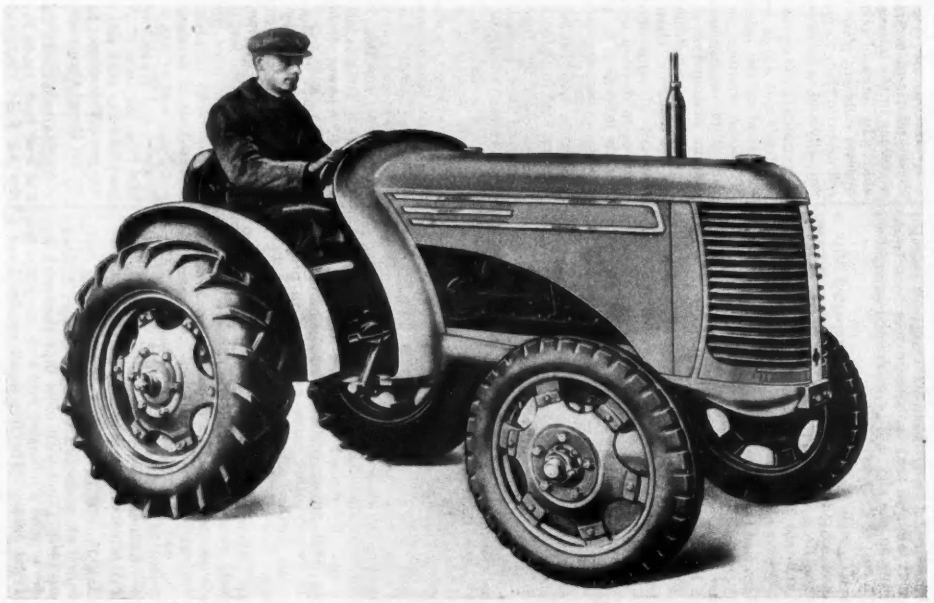


JOHN DEERE TRACTOR—OLDING



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The Engineer

JULY 7, 1939

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CENTENARY OF THE ROYAL SHOW

THE industry of agricultural engineering was hit severely by the Great War and more severely by the revolution in Russia. That revolution led to the almost complete loss of Siberia as a market and cost firms many hundreds of thousands of pounds in bad debts and the sacrifice of assets in the form of stock carried in stores and showrooms. An effort to restore the industry by a great amalgamation of interests failed completely and added to the financial embarrassments instead of removing them. Yet withal the industry itself is a very important one, and it serves another industry—agriculture—which used to be the largest in the land and is still amongst the first few. In these circumstances particular interest attaches to the fact that it is just one hundred years ago since the Royal Agricultural Society was founded. The first Show was held at Oxford in July, 1839. There was a good deal of opposition to it and a good deal of ridicule. It appears to have been quite a small affair in which a dinner took a leading part. The exhibition of stock and produce was, as it is to this day, the principal feature; but a beginning, at any rate, was made with a display of machinery and implements. With the exception of one firm whose name deserves to be especially recorded—Ransomes, Sims and Jefferies—which had a considerable range of implements on its stand, the exhibitors, to judge from the catalogue, showed no more than a single implement each. From this very modest beginning the exhibition of implements and machines has become, under the influence of prizes and international recognition, not only an event of the first importance to the agricultural engineering industry, but the model on which lesser and local shows were founded.

But whilst the Royal Show has pursued its principal object of introducing to farmers and agriculturalists new and improved implements, there is another respect in which it has served engineering. We have failed to find out with certainty when the first of its famous series of Trials was held, but there is no doubt that at the meeting in Wolverhampton in 1871 there were competitive tests of steam cultivating machines. Five years later there was—it sounds rather odd—a trial of dynamometer and friction brakes, and in 1890 there were held at Plymouth trials of light portable engines which are still remembered by those who were associated with the industry in the last century. In those days feelings used to run high and the excitement was as keen and as great amongst the workmen and the men engaged upon the engines or implements in the shops as amongst the protagonists. Indeed, the desire to win was so acute that it not infrequently overbore the principles of the contestants. The machines arrived on the trial ground a day or two before the official tests and were as carefully guarded day and night as race horses before a great event. They were wrapped up in tarpaulins, to protect them against marauders as much as against the weather, but if one were not wakeful a small boy might creep beneath with a handful of sand, or your oilcan might be doctored with a pinch of emery. At the Trials the excitement ran high. The competitors were each given a weighed supply of coal. The careful drivers went over it practically lump by lump, throwing out all rubbish, and were not above attempting to add to their stock either from their capacious pockets or by surreptitiously purloining from others. We recall one well-known maker who fired his engine personally, snapping the fire-door open and shut as quick as lightning and shooting in no more than a pound or so of coal at a time with a brass shovel he had borrowed, so it was said, from his bank manager. Those "good" old days are no more. Interest in steam farm engines has been displaced. The steam engine has been assaulted by the oil engine, but the R.A.S.E. will always be remembered for the part it played in the development of the older prime mover. The new power came in for its turn in 1894, when Professors Ewing and Capper conducted tests at the Cambridge Show, and again in 1901 at Cardiff. Self-moving vehicles were tried at Birmingham in 1898, and on several subsequent occasions. In 1903 the Society took a different line and organised a competitive test of windmills, which we reported very fully at the time. All the Trials we have mentioned were of general interest to engineers, but there have been many more of especial interest to the makers of agricultural implements.

From this brief outline of its activities it will be seen that the Royal Agricultural Society of England has throughout its life of one hundred years done much of great value to engineering over and above its principal duty of encouraging trade and disseminating knowledge. Alas! that some of the firms whose names were known in the four corners of the earth and which had great stands at the Shows are no more. But the industry goes on. New life blood has been brought into it by American influence, and if the old thrills are no longer experienced there is no lack of endeavour to keep up the high position of British agricultural machinery. Competitive trials of machinery are not favoured as they were, but the pursuit of improvement continues without that incitement, and the flow of inventions never seems to abate—there is always something new to be seen at the annual Shows. This week the meeting is being held in the Great Park, Windsor, and is, as will be seen from our account of it, of exceptional interest. This is not the first time that Windsor has been selected; but it is particularly fitting that for the centenary of a "Royal" Society the invitation of the King to hold it in the traditional home of a long line of English monarchs should have been accepted. In congratulating the Society on its long life, we desire, on behalf of the industry and profession we represent, to thank it for the great services it has rendered to engineering.

"Pacific" Locomotives in India

ON July 17th, 1937, there occurred at Bihta, 15 miles from Patna, on the East Indian Railway, one of the worst railway accidents on record. No less than 107 Indians were killed outright and 65 were injured. The train was the Punjab–Howrah express, and it was drawn by a "Pacific" "X B" locomotive. The accident was brought about by the derailment of the engine on an embankment. At an inquiry held in India by Mr. Justice Thom, the conclusion was reached that the particular type of engine was liable to hunting at high speeds, and that it had distorted the track. A year later the Government of India appointed a Committee to report upon "Pacific" locomotives of the "X B" and other classes. The Committee visited India, and wrote a report which was published in India on June 27th, and will no doubt be available in this country in a few weeks' time. Fortunately, we are able through the courtesy of Lieut.-Colonel A. H. L. Mount, the Chairman of the Committee, to print in the present issue the conclusions arrived at. Whilst they are incomplete without any account of the reasons that led up to them, yet they will be read with interest by all railway men. We hope to publish other sections of the report at later dates.

Before commenting on the report, it is desirable to give the names of the members of the committee. As already said, Lieut.-Colonel A. H. L. Mount, Chief Inspecting Officer of Railways, Ministry of Transport, was the Chairman. The fitness of a man with his experience of railway accidents for chairman is plain to all. With him were Mr. Raymond Carpmael, Chief Engineer (Civil) of the Great Western Railway, and Rai Bahadur P. L. Dhawan, who held at one time an equivalent position on the North-Western Railway of India. On the mechanical side were Monsieur Robert Léguille, Regional Chief Mechanical Engineer, French National Railways, and Mr. W. A. Stanier, Chief Mechanical Engineer of the London Midland and Scottish Railway. The composition of this committee could hardly be bettered. From the first there was no doubt that neither the road alone nor the engine alone could be considered responsible for the derailment at Bihta. It was therefore desirable that the civil and mechanical branches of railway engineering should take part in the investigation. That they have reached unanimous decisions adds greatly to the value of the report. Here we have four of the leading authorities in their own line, led by a fifth whose experience of railway accidents is unsurpassed, investigating a problem of major importance to railways, all coming to the same conclusion and signing a report which is a masterpiece of its kind. The terms of reference to the committee were to consider the design and operation of engines of three types and to advise upon the suitability of the design for their work, the suitability of the procedure followed in preparing and approving the designs, and the circumstances attending the purchase of the engines. Furthermore, it was asked to specify the conditions under which the engines could be used with safety, any modifications which would have the effect of increasing the scope of the engines, and any modification that should be made in the procedure followed for the trial and purchase of engines. It will be seen at once that the inquiry is divisible into two principal parts, one which may be described as administrative and the other technical. It is desirable to make this explanation, since without it the purpose of the conclusions printed on another page of this issue would not be clear.

We have examined the report with profound interest. It is a very big document—a veritable treatise on the locomotive as a vehicle—and if we admit that we have given more attention to the technical than to the administrative side of the

inquiry, our action will be condoned by all railway men. One point that struck us in our reading was the insistence upon the inter-relationship of locomotives and the roads they are to run upon. Although that is a commonplace, it is not always observed as faithfully as it should be, and the committee very rightly made a strong point of it. In that respect, no less than others, the report may be regarded as of far more than local importance. Indeed, we do not hesitate to say that there are no railway men in any part of the world who will fail to find something useful in it. The committee conducted its inquiry in a very practical manner. It was not content only with the examination of witnesses, drawings, charts, &c., but actually travelled, between September 2nd and October 14th—at the end of the monsoon—nearly 7000 miles by rail, having for most of the time its headquarters in a special train. During this trip it interviewed a large number of railway officers and visited many workshops and running sheds. Furthermore, members of the committee rode no less than 3100 miles on the footplates of twenty-nine engines of a variety of types at the same time that the condition of the track was being observed by a Hallade recorder. As might be expected from the composition of the committee and the nature of its activities, there is nothing the least bit academic in the report. The academic is always stultified in the handling of locomotive problems by the number of variables which the road and the conditions of service impose, and safe conclusions can only be reached by practical observation and long experience. That does not mean that scientific inquiries are valueless; far from it, but it does mean that, however carefully calculations may be made, a large measure of uncertainty will inevitably remain. The only method of reducing that uncertainty is by the careful observation over prolonged periods of locomotives running on the track for which they are designed, and we are happy to note that that form of research amongst others is recommended by the committee. There is so much in the report that calls for discussion that we look forward to returning to it at another time. For the moment, we end with congratulations to the committee on the admirable conclusion of its labours.

"Pacific" Locomotives on Indian Railways

WE give below the Concluding Remarks of a Committee which, under the chairmanship of Lieut.-Colonel A. H. L. Mount, was appointed by the Government of India in July, 1938, to make a report on Indian "Pacific" locomotives. Besides Lieut.-Colonel Mount, the Committee included Mr. Raymond Carpmael, Rai Bahadur P. L. Dhawan, Monsieur Léguille, and Mr. W. A. Stanier, and was assisted by Mr. E. S. Cox of the L.M.S. Railway, and Mr. K. C. Bakhle of the G.I.P. Railway. The report was published in India on June 27th, and it is through the courtesy of the Chairman that we are able to put this part of it before our readers at once. In a Leading Article we comment on the report as a whole. It is a very remarkable document of great size, and we propose to give other sections of it as space permits.

We have completed our task in the anticipation that discussion of the subjects under our terms of reference will help towards a better understanding of past difficulties in India, and will give a clearer lead for the future. We are aware that our explanations of the complicated phenomenon of hunting has certain limitations, but our recommendations, which are based on practical considerations and experiments, should result in suppressing abnormal oscillation. Arising from our assumptions and deductions, we hope that further investigations will be made, which should increase knowledge of the relationship between track and locomotive, and, consequently, improve operation and enhance safety. For convenience, we have made a summary of our principal recommendations, which will be found, duly referenced, as Appendix I.

We are not called upon to consider the justification for the policy of expansion which was being pursued during the years following the Acworth inquiry; but it is clear that optimistic views were held as to the trend of trade and traffic. Further, the necessity for generously and quickly replacing old locomotives, while curtailing the fuel bill and pursuing standardisation as another avenue for economy, were matters which were looked upon as of paramount importance, little progress having been possible during and immediately after the Great War.

Accordingly, 218 "X" class "Pacific" engines, out of 284, were authorised in less than three years between 1925 and 1928. We are satisfied that such large and repeated orders would not have been placed had not all concerned been confident as to design, which followed established practice and available experience in Great Britain at the time. Nevertheless, in view of the warnings received, the wiser course for the Board to have taken, as indeed they admit to-day, would have been to continue the purchase of further well-tried B.E.S.A. engines (suitably modernised), pending the pursuance of the policy of thorough trial of the new "Pacific" types, a policy which the Board had previously laid down and are resuming in the case of the new "W L" class "Pacifics."

In view, however, of the state of knowledge and method of testing adopted at the time, it seems unlikely that, except for reducing the number of "Pacific" engines now in service, adherence to this policy would have assured immunity from subsequent troubles or altered the conditions of operation which have led to this inquiry. Indeed, one main defect in design, namely, the weakness of the bogie control springs, though recognised as early as January, 1929, was not effectively pursued. In fact, its correction, with the other basic defects which render these engines so sensitive to condition of the track, has unfortunately been unduly delayed, on account of uncertainty and lack of decision with regard to fundamental requirements.

One test of railway efficiency is the rapidity with which preventive measures are adopted when a reasonable factor of safety has been shown to be lacking. It is desirable that formal inquiry by Government Inspectors should, *prima facie*, be undertaken in every case of passenger train derailment, and their reports should be circulated without delay. We feel that in the past a too rigid departmental outlook was prone to exist, and may have reacted detrimentally; but if confidence has been shaken, this has resulted as much from the time taken to make effective alterations as from lack of knowledge of what has already been done to improve both engines and track.

The action taken since 1929 has been described, and we have had regard to the apparent delay in realising the underlying causes of the trouble experienced, namely, the punishing effect of imperfectly controlled engines on indifferent portions of track. Although it may appear to-day that the circumstances leading up to the earlier derailments were not fully recognised and taken advantage of at the time, we are generally satisfied that the major defects, which have affected the engines as vehicles, have been under constant consideration by the Railway Board.

Developments, however, took place slowly because of the complexity of the problem of hunting, the lack of quantitative data, and particularly because of the conflicting nature of the reports received. It was not until research was commenced by the Board that it became possible, for the first time in India, to bring the relationship between engine and track under scientific examination. The Board are now in possession of autographic records and quantitative results, which were placed at our disposal and which have been of great assistance to us in arriving at our conclusions.

We consider that the introduction of "Pacific" engines into India was justified, and that they have a definite field of use for efficiently meeting certain traffic and technical requirements; a good big engine is always better than a good little one from the operating point of view. At the same time, we were informed that a large amount of business could be more economically undertaken with improved and modernised "B.E.S.A." type engines. We draw attention, on financial and traffic grounds, to the desirability of reducing the weight of trains and of individual rolling stock. We feel that serious consideration should be given to this subject, and to the development of additional standard designs of engines.

Our investigations have proved beyond doubt that "X" class "Pacific" engines are particularly sensitive to defective portions of track and to poor conditions of engine maintenance. Either or both induce oscillations which may readily build up to serious hunting at certain speeds. Further, owing to the side controls of the bogie and hind truck being inadequate, this phenomenon sets up heavy flange forces at the coupled wheels, which may result in track distortion or gauge spreading, where conditions of formation, construction, or maintenance are unfavourable.

With regard to the suitability of the track for these engines, there is little doubt that when they were introduced they immediately reacted to weak spots; but we are satisfied that, generally, suitable action by speed restriction and strengthening was taken to meet the situation which arose from introducing machines, the capacity of which may be said to have been materially ahead of the characteristics of the track. This was a case of history repeating itself. It has happened in other countries, and we make this comment with no intention to criticise, having regard to the results of recent research and experience which were not available in the past.

In our opinion, the main avenues by which difficulties can be surmounted in future concern the design and maintenance of the locomotive, the construction and maintenance of the permanent way, and the speed of operation. We desire to emphasise that design must have regard to the inescapable features of the country and to the financial limitations which control the conditions of both track and engine. From what we saw of track, shops, sheds, and engines, we were, on the whole, favourably impressed by the standards of maintenance; but the fall in expenditure is significant of the efforts being made towards retrenchment.

It is no part of our remit to consider the details of the Government's financial policy, and we do not suggest that, up to the present, this policy has impaired the efficiency of the railways; but we feel that steps should be taken to guard against the conceivable development of a position whereby the allocation of adequate moneys to the railways may be jeopardised. Indeed, it seems that already there may be some tendency towards too easily carrying economy beyond the limit, as based perhaps on theoretical rather than on practical considerations. While there appears to have been lack of appreciation regarding the design, as a vehicle, of the "X" class "Pacific," adequate maintenance of both engine and track is of great importance in considering the problem of the reactions of one on the other.

We feel therefore that it is our duty to draw the attention of the Government of India to the comparative ease with which false economy can be effected, with perhaps misleadingly creditable results, and to the serious economic and psychological consequences of persistent financial pressure in this respect. High-speed operation of heavy modern engines, even of perfect design and upkeep, will cause inestimable damage to unsuitable track within a very short period. Deterioration can only be made good over an extended period, and at considerable expense, far in excess of that incurred by appropriate systematic maintenance. Before the advent of "Pacific" engines, heavy train services were worked by comparatively small engines, and maximum speed was limited by boiler capacity. The larger "Pacifics," with their greater boiler horse-power, are able to sustain higher average speeds, thus maintaining maximum speeds for longer distances, and therefore increasing the stress on the track, showing up weaknesses more easily and more frequently.

At any given speed, the flange forces acting through an engine depend on the measure of track irregularity which is encountered under load. The value of these forces depends on the extent to which oscillation of the engine develops, and the principal means of control in this respect is the sufficiency of the reactions afforded by the guiding wheels, in relief of the coupled wheels. The extent of the lateral forces brought to bear on the track has only recently been appreciated in India. The necessity therefore for the continuance of the research, which has already been initiated, is fundamental. In addition to the extended use of the Hallade track recorder, consideration should be given to the introduction of special test

cars for the co-ordinated and direct measurement of track irregularities and flange forces.

We recommend an enlarged organisation for research and standards, so that technical development can be progressively dealt with, and the necessary training and experienced gained, to enable India as time goes on to cope with her own problems, including the building of broad gauge locomotives. We also refer to the necessity for improving the means of collaboration between the administrations, the Railway Board, and the consulting engineers.

We draw particular attention to the present speed of operation, and to the necessity for strictly complying with permissible maxima, as laid down by the chief engineers. Such maxima should have regard to all the circumstances, and, in addition to the working speed, should be notified to all concerned. Although it is common knowledge, confirmed by our observations in India, that experienced drivers can gauge their speed within narrow limits, they are prone to underestimate it when decelerating to observe speed restrictions. We recommend that all engines operating mail and express passenger trains be fitted with speed indicators. We have already referred to the importance of maintaining the unfettered discretion of the responsible civil and mechanical engineers in respect of safety.

The record of safety in operation of Indian railways is an enviable one. The 284 engines, to which our terms of reference apply, have run no less than 90 million miles, and the incidence of derailment has been mainly confined to the first five years of service. The well-merited confidence, however, which was placed in the railways by both the public and the staff appears to have been shaken, following the accident at Bihta, the unfortunate results of which were quite exceptional.

We hope that our recommendations, and the action which should follow them, will re-establish confidence, and that this report will focus attention on the interdependence of the standards of construction and maintenance in relation to speed and load, as affecting both track and locomotive. There appears to be no reason why "X" class "Pacifics" should not have many years of useful and reliable work ahead of them provided that they are modified as recommended, that attention is paid to particular aspects of track and locomotive maintenance, and that speed of operation is adjusted to prevailing conditions in both respects.

Literature

Aircraft Design. By C. H. LATIMER NEEDHAM. Vol. 1, *Aerodynamics.* Chapman and Hall. 215 pages. 13s. 6d. net.

THE lack has been felt for some years of any really outstanding book on aeronautical principles and the resulting aircraft design, which would be equally clear, concise, authoritative, and accurate. Many authors have attempted to attain these important objectives, but the right book had still to be awaited.

Mr. Needham is the latest of the competitors. He tells us that his book is based on experience in the design, construction, and piloting of aircraft, and on lecturing on aeronautical subjects during a period of over twenty years; he was at one time an education officer under the Royal Air Force and is now lecturer on aeroplane design at the Battersea Polytechnic. He divides the carrying out of his task into two separate parts—Volume 1, now published, which deals with the principles of flight and stability, whilst the volume to follow will, he tells us, deal mainly with the mathematical treatment of design, including the materials used, the special case of seaplanes, and experimental testing in general. It is a pity from the reviewer's point of view that both volumes could not have appeared together, for then the complete picture presented by the author could have been seen as a whole. However, we have Volume 1 before us, and the question is, how far does it go to fill the gap of which we have spoken? The verdict, as will be seen by what follows, is on the whole not unfavourable to Mr. Needham.

The subject of this first volume is divided between fourteen chapters, of which five are concerned with general theory and aerofoil shapes, followed by sections on the arrangement of lifting surfaces and types of actual aircraft, and they in turn by chapters on stability and control. All of them are good. The book ends with a treatment of airscrews and the performance of aeroplanes. Really it does not quite end with them, since the author rather unexpectedly throws in a final chapter on parasite and interference drag, reminding one rather of a cinema film cut up for editing and put together in an odd order. At the close of the first chapter the author in describing the R.A.E. vertical tunnel used for the test of free-spinning models calls it "the latest development in wind tunnel work." This is somewhat misleading, as better examples of recent developments would be, to quote but a few, the new "Gottingen" tunnel, the new free rectilinear flight tunnel, and the very high-speed tunnel in the U.S.A. and newer developments at the R.A.E. itself.

A pleasing feature of the book, which is often but little used in British publications, is the frequent employment of polar diagrams to show lift and drag curves for aerofoils. In fact, the whole section on aerofoils is well done. The author's illustration of the air flow through a multi-slot wing on page 124 will, however, prove rather disconcerting to any aircraft constructor who might think of using such a wing, despite the attraction of so high a lift coefficient as that held out as a bait, namely, 4·0. The account of variable-lift devices shows that the author has familiarised himself with the results of the latest research investigations on this growingly important subject, and the illustrations are refreshingly clear and workmanlike. He summarises the order of efficiency as slotted flap, plain flap, Zap flap, and split flap, and favours the slotted flap for take-off and the split flap for landing.

Towards the end of the book he discusses the problem of the airscrew fully and effectively, but in speaking of its gyroscopic effect omits, oddly enough, the distinction, so important in manœuvre, that exists between the two-bladed variety and those with three blades or more.

We notice a few misprints in the chapter on "Aeroplane Performance," and they will no doubt be corrected in any further edition; but so long as they stand uncorrected they will puzzle the less-skilled students.

We welcome Mr. Needham's book as being much above the average in its class, and we await with interest the completion of his task.

BOOKS RECEIVED

Magnesium, Magnesite and Dolomite. By J. Lumsden, B.Sc. London: Imperial Institute, S.W.7. Price 2s. 6d. net.

Cyclopædia of A.R.P. Equipment. London: Air Defence Equipment Service, 4, Lisle Street, W.C.2. Price 6d. net.

Directory of Coventry Manufacturers. Edited by J. Tayler. Coventry: City Development Officer, Council House. Issued gratis.

Institute of Welding Second Progress Report of the Research Committee. London: Institute of Welding, 104, Victoria Street, S.W.1.

F.B.I. Register of British Manufacturers, 1939–40. London: Federation of British Industries, 21, Tothill Street, S.W.1. Price 15s. net.

Theory and Design of Valve Oscillators. By H. A. Thomas, D.Sc. London: Chapman and Hall Ltd., 11, Henrietta Street, W.C.2. Price 18s. net.

Elements of Practical Aerodynamics. Second edition: By B. Jones. London: Chapman and Hall, Ltd., 11. Henrietta Street, W.C.2. Price 18s. 6d. net.

The Theory and Practice of Reinforced Concrete. By C. W. Dunham. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 25s. net.

The Essentials of Reinforced Concrete Design. By R. F. B. Grundy, B.Sc. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 10s. 6d. net.

Aircraft Design: Volume 2 Aerostructures. By C. H. Latimer Needham, M.Sc. London: Chapman and Hall Ltd., 11, Henrietta Street, W.C.2. Price 16s. net.

Universal Directory of Railway Officials and the Railway Year Book, 1939–40. London: Directory Publishing Company, Ltd., 33, Tothill Street, S.W.1. Price 20s. net.

A.R.P. Bulletin No. 2: Brick Shelters for the Protection of Personnel. London: Clay Products Technical Bureau of Great Britain, 90, Ebury Street, S.W.1. Price 2s. 6d. net.

Checking Spur Gear Teeth: The Base Tangent and Pin Systems. By F. W. Shaw, M.I.P.E. London: Emmott and Co., Ltd., 28, Bedford Street, W.C.2. Price 1s. net.

Regulations for the Electrical Equipment of Buildings. Eleventh edition. London: Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Price 1s. 6d. net.

Aero Engines: Inspection of During Manufacture, Overhaul, and Test ("D" Licence). Sixth edition. By A. N. Barrett, A.M.I.A.E. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 3s. 6d. net.

Proceedings of the Fifth International Congress for Applied Mechanics, held at Harvard University and the Massachusetts Institute of Technology, September, 1938. Edited by J. P. Den Harlog and H. Peters. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 30s. net.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

STEAM PLOUGHS AND THE AGRICULTURAL EMERGENCY

SIR,—I observe with pleasure from the correspondence columns of your issue dated June 30th that Mr. M. H. Royston is an upholder of the cable system for heavy land operations, but considers that modern conditions demand the use of the diesel engine as the source of power. So do I, but in advocating steam plant for the purpose I am trying to evaluate the lessons of the future rather than the evidence of the past. In the preparation against war nothing ought to be left to chance; we cannot dismiss vital considerations with a pious hope that all will work out satisfactorily in the end. We are bound, therefore, to arrange in advance for all our resources to be utilised to their best advantage. As liquid fuel cannot be referred to in these terms, demand should be kept, outside the requirements of the fighting forces, to its irreducible minimum. Has Mr. Royston considered the enormous quantities of petrol and the like required for the future Air Force, transport, as well as flying, together with the greatly enhanced demands of the Navy and Army? All this has to be brought into the country under circumstances of great difficulty by ships that are too often dependent themselves upon liquid fuel. In addition, numbers of factories have sprung up away from the railways dependent upon road transport for staff as well as supplies and output. Very careful stock of any fresh commitments in this direction should therefore be taken, and it would appear far safer to develop the use of home-produced fuel where possible even if it is a little more costly at the moment. Economics have no place in warfare.

I agree that the farmer always complains about the cost and trouble of carting the necessary water and coal, but it is not as bad as it is made out, certainly not as much as the 6s. 6d. quoted; even with this surcharge the cost of ploughing should not exceed that of tractor work and the work will be done better. This surcharge usually covers the cost and cartage of coal and water, the engines finding the actual vehicle.

My final contention is that the steam plant and the staff accustomed to its use and repair are available and that this cannot be said of the diesel plant; it would be cheaper in first cost to repair the former rather than to purchase a similar number of the latter. It certainly would be quicker, which seems important at the present moment. Thanking you for the space that you have kindly afforded.

July 1st. J. G. B. LAWS.

THE NATIONAL GRID IN WAR TIME

SIR,—The apologia which is offered for the monumental error of developing any centralised system of power distribution in this country during the past ten years is far from convincing, for though it is true that the grid system enables a bombed station to be replaced by another, no mention is made of the vulnerable lines of transmission which are assumed to make this substitution possible.

In all the volunteer arrangements I have seen no word of any proposal to form a grid patrol. I was permitted to suggest this course in the columns of the late *Morning Post* several years ago, and I suggest that it is high time to call attention to its urgent need again.

S. P. CHRISTIE.

July 1st.

ANOTHER L.M.S. CENTENARY.—The centenary occurred on Tuesday, July 4th, of the public opening of the first section of the Manchester and Leeds Railway, later part of the Lancashire and Yorkshire Railway, and now part of the London Midland and Scottish Railway system. Proposals for a railway between Manchester and Leeds were mooted as early as 1825, and the route was surveyed and the line constructed by George Stephenson, who regarded the Summit Tunnel, between Littleborough and Walsden, as the greatest piece of railway engineering he had yet achieved. This tunnel is 2885 yards long and is the eighth longest on the L.M.S. system; it cost over £250,000, and the materials used in its construction included 23 million bricks and 8000 tons of cement. At its deepest point the tunnel is 300ft. below the Pennines. It was owing to the Summit Tunnel being unfinished that the line could not be opened further than from Manchester to Littleborough, 14 miles, on July 4th, 1839. The original Manchester terminus of the Manchester and Leeds Railway was at Oldham Road, which is now an important L.M.S. goods station. Passenger trains were transferred to Hunt's Bank (later Victoria) Station in 1844. Among interesting features of the railway were its employment at first of the unusual gauge of 4ft. 9in., on the whole route between Manchester and Leeds, there were 22 viaducts, 134 other bridges, and eleven tunnels.

Oil-Electric Railcars for the S.N.C.F.

THE Société Nationale des Chemins de Fer Français (S.N.C.F.) has recently put into service on the Grenoble-Col de la Croix-Marseille line of the P.L.M. section of the railway a number of new oil-electric high-speed railcars. We illustrate in Fig. 1 one of these vehicles, of which there are nine, each equipped with two sets of 300/360 B.H.P. Saurer-Oerlikon oil-engined generating sets. The mechanical parts of the railcars were constructed by the Société

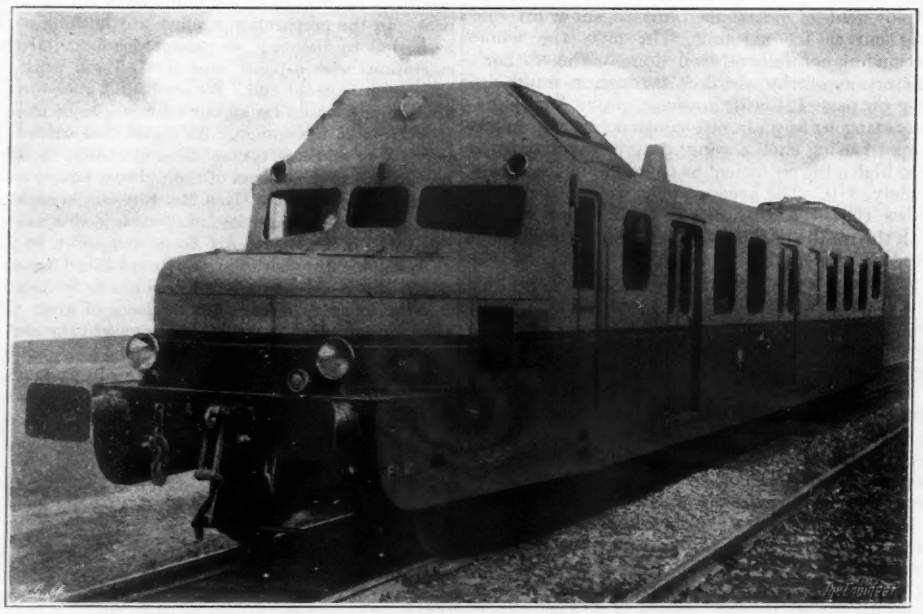


FIG. 1—600 B.H.P. RAILCAR FOR THE FRENCH STATE RAILWAYS

Nouvelle des Etablissements Decauville Ainé, at Corbeil, near Paris, which acted as main contractors.

In Fig. 2 is reproduced a simplified profile of the line, which is a mountain one, 195 miles long. The figures on the diagram give the average gradients per cent. The motor coaches also work partly on the St. Auban to Digne and Veynes to Briançon branch lines, in a district situated at some points as high as 4260ft. above sea-level. A considerable portion of the line presents gradients of 1 in 40, and there are numerous curves, while in winter large accumulations of snow are encountered.

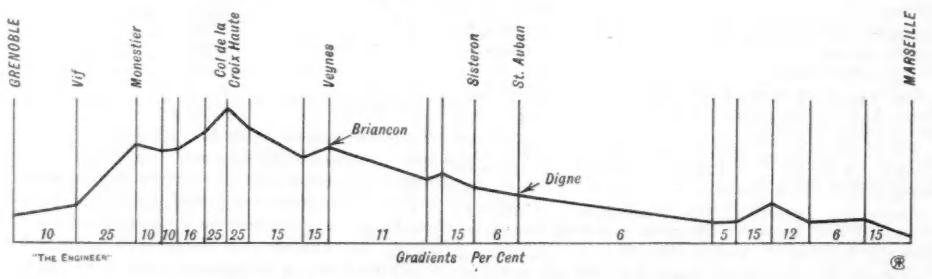


FIG. 2—PROFILE OF THE GRENOBLE-MARSEILLE LINE

We are informed that each railcar is capable of hauling a trailer over the whole length of the line. With full load a motor coach and trailer weighs 75 tons, the weight of the motor coach alone being roughly 49 tons. Two such units can be coupled together when necessary, and thereby a double train is formed, providing accommodation for about 300 passengers seated. It was not considered necessary to provide multiple control for this arrangement, since frequently the train is divided into single units, either *en route*, at junctions, for example, or for the return journey, and in these circumstances a driver is required for each motor coach in any case.

In designing the vehicles it was realised that the power-to-weight ratio would have to be relatively high, in view of the severe working conditions already mentioned. It amounts to about 10·5 H.P. per ton, measured at the driving wheels, and as a result high acceleration can be obtained and 50 m.p.h. can be reached on level track in less than one minute. With the motor coach and trailer fully laden, on gradients of 1 in 40, steady speeds ranging from 34 to 40 m.p.h. can be obtained, according to the track, curve, and wind conditions. The maximum service speed is 68 m.p.h., but it may be mentioned that on the occasion of a test run 85 m.p.h. was reached without difficulty.

In view of the mountainous character of the line, the vehicles are fitted with three different mechanical brakes—the ordinary hand brake, an automatic compressed air brake acting on separate axle brake drums, and a pneumatic regulating brake acting on the wheel rims through brake blocks. In addition, it is possible to incorporate, if necessary, an electric brake, making use of the traction motors, but this provision has not been required so far.

In Fig. 3 is given a diagram of the electrical transmission system. It represents a system developed by Oerlikon, Ltd., known as a "combined battery and self-excitation" arrangement, whereby auxiliary machines and exciters are dispensed with, only three small resistances being required, which are light and reliable. In the diagram A represents the generator, B B the traction motors, and C a battery; D is the resistance system already mentioned, E is a switch for the traction motors, and F is the starting switch.

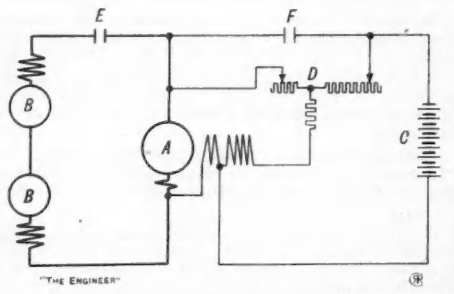


FIG. 3—DIAGRAM OF CONNECTIONS

This arrangement permits, furthermore, the advantage of automatic starting without special relays or other auxiliary apparatus, so that the driver can set the controller on the desired running step, whilst the coach is stationary without overloading the oil engines and without the necessity of watching instruments or indicating apparatus. It is claimed that the system simplifies considerably the duties of the driver, who can devote his whole attention to observing the track.

As previously mentioned, the Oerlikon system dispenses as a rule with all auxiliary machines. In the present case, however, each oil engine is equipped with a small battery-charging dynamo, and the battery is of large capacity. This provision is on account of the long descending gradients, during which the oil engines are closed down and during which the lighting system and the brake compressor may discharge the battery rather heavily. The charging machines are ordinary automobile dynamos, driven by V belts from the Saurer oil engines.

Reports state that the vehicles have given excellent results in service, and that they are specially notable for quiet and smooth running. This feature must, in part, be ascribed to the electrical transmission, which is claimed further to present advantages over other systems on mountain sections by reason of the ease of constant regulation. An average day's run is 125 to 155 miles, with occasional mileages as high as 500. In view of the good results obtained with the vehicles, we are informed that the S.N.C.F. has recently decided to order from the same contractors ten further similar units.

The Vulcanisation Process and Its Origin*

THE year 1939 is being celebrated in the United States as the centenary of the discovery of the rubber "vulcanisation" process (by which the valuable elastic properties of the substance are made available in a form unaffected by variations of temperature). During September at the annual meetings of the American Chemical Society, papers are to be read on the work of (1) Charles Goodyear and (2) Thomas Hancock. It was in 1839 that Mr. Nathaniel Hayward, proprietor of the Eagle Rubber Company, East Woburn, Massachusetts, took out a patent for a process of which the essential feature was exposure to the effect of sunlight of a mixture of rubber and sulphur. The patent was acquired by Mr. Charles Goodyear for 200 dollars, and both Hayward and Goodyear continued experiments with the object of discovering a method of extending the purely superficial effect of "solarisation" through the whole thickness of any rubber treated.

DISCOVERY IN AMERICA

In 1834 there was an almost complete collapse of the rubber-manufacturing industry in the United States, and over a period of some years Goodyear was in considerable financial embarrassment. No doubt the cause of the collapse was defects inherent in the articles manufactured, for rubber shoes failed to give satisfactory service and rubber coats became sticky or cracked. Goodyear was among many made bankrupt. For a second time he saw the inside of a debtors' prison, but he took in with him a slab of marble, a rolling-pin, and a supply of rubber and chemicals, and set up a laboratory within the prison walls. It was while in prison that he discovered, among other things, that adding magnesium to rubber counteracted its stickiness. In the light of this discovery he set to work with his family as soon as he was free to manufacture "gum elastic" shoes by the "magnesium" process, involving solution of the rubber in turpentine, and later the addition of lamp black. He also tried the effect of mixing one chemical after another with rubber, and finally discovered that, with quicklime and water instead of turpentine, he could make a dry rubber sheet. Sheets so treated appeared capable of resisting heat as well as rain, but he was fortunately prevented from attempting to exploit the process commercially by the timely discovery that acid, dropped on the sheets, neutralised the lime, so that they again became sticky. About this time Goodyear acquired from Nathaniel Hayward the patent already referred to, whereby sulphur was spread on rubber sheeting and dried in the sun. Legend has it that in 1839 he was mixing a quantity of rubber and sulphur when some of it dropped on to the top of a hot stove, and, as a result, he made the discovery that formed the basis of his later patent. But there was no financial backing to be had, and for two years nobody outside his own family would believe that the piece of charred rubber he carried in his pocket was of value. Once again he was in put in prison for debt. At this point a brother-in-law gave Goodyear further capital, and in 1843 he finally filed his claim for a patent on a process similar to what is now known as vulcanisation. His application was granted to him eleven months later, in June, 1844.

DISCOVERY IN ENGLAND

Goodyear was not the sole claimant to the discovery of vulcanisation. The rival claims of Goodyear and of Thomas Hancock (founder, in London, England, of the first concern ever to be engaged in the manufacture of products from india-rubber—or, as he called it, caoutchouc) were the subject of much controversy in the industry some years ago, but recently at least there has been tacit agreement to divide the honours. It appears conclusive, from records left by Hancock himself, that his successful researches in this process were entirely independent. In any event, neither Goodyear nor Hancock has any just title to share in centenary celebrations this year, for the patents of both these pioneers relating

* From the *Chemist and Druggist*, Annual Special Issue, June 24th, 1939.

to vulcanisation were entered only in 1844. Hancock, who founded his business in 1820, had already made valuable contributions to the study of rubber chemistry and manipulation, and was in fact the discoverer of rubber "mastication." For some years he had been conducting extensive experiments to discover a method of rendering rubber unaffected by heat and cold, but comparative lack of success had diverted him to more profitable fields. In the autumn of 1842 a colleague, Mr. W. Brockedon, showed Hancock some small pieces of rubber brought from America by a Mr. Stephen Moulton who, it is understood, brought them as agent for Mr. Charles Goodyear. The last-named, being in one of his periods of financial embarrassment, was desirous of disposing of his secret and thought Hancock a likely buyer. Hancock describes in "Personal Narrative of the Origin and Progress of the Caoutchouc or India-rubber Manufacture in England," published in 1857, how Brockedon cut two "very diminutive bits" from two of the already small pieces which had been handed to him. In the light of this evidence from the United States that what he had in mind could certainly be achieved, he now set to work with renewed concentration. He made experiments with numerous substances, such as magnesium silicate, fuller's earth, whiting, ochre, asphalt, and graphite, producing many compounds with applications in manufacture, but still none with the property he was most anxious to impart. "It is a singular fact," wrote Hancock, "that although sulphur had long since been compounded with rubber by myself in this country and in America by others, yet its true value for producing such a result had never been even dreamt of by any of us. I made no analysis of these little bits nor did I procure, either directly or indirectly, any analysis of them. In making my experiments, I depended entirely and solely on my own exertions, having some confidence in an experience of upwards of some twenty years of unceasing application to the manipulation with my hands of the substance I was dealing with. . . . I knew nothing more of the composition of the small specimens given me by Brockedon than what I or any other person might know by sight or smell." From the first Hancock had had a strong impression that the rubber underwent the "change" either while in a state of solution or when greatly softened by heat. He therefore experimented with numberous substances, alone and in combination; in some, sulphur was included and in almost all heat was applied, though no note was taken of the degree of heat used. When making the compounds with solvents, he first dissolved the rubber, then "worked up" the other substances with it. Sometimes, to expedite drying, he heated the mixtures over a lamp or baked them in an oven. In looking over some former experimental scraps, he one day noticed, in some of those containing sulphur, that parts appeared to differ from others in the same specimen. This led him to dissolve sulphur in oil of turpentine, raise the temperature of the turpentine to boiling point (when it takes up sulphur freely), and dissolve rubber in the resulting solution. The result was encouraging, but still unsatisfactory. "I cannot, of course, now say in which scrap or at what particular moment I struck out the first spark of the 'change.' because I had a great number of scraps under my hand at one time, and I also found that, when exposed even to ice, the stiffening effect of cold was not immediately apparent. I was thus, during my comparative ignorance of the nature of my discovery, frequently misled and disappointed from two causes. First, what it was in the successful compounds that produced the effect; and, secondly, I was ignorant of the importance of the degrees of temperature employed, as well as of the period to which any specific compound required to be submitted to heat. These points could be ascertained with exactness only by time and vigilant watching, and this I began immedately to set about. As the law allows a patentee six months to work out his discoveries before he is called upon to enrol his specification, I applied for and obtained a patent for my inventions, which passed the Great Seal on November 21st, 1843."

IN COMMAND OF THE SECRET

At this stage an idea occurred to Mr. Hancock that was to put him in command of the whole secret of vulcanisation. In considering some of the effects produced by the high degree of heat that had been employed in making solutions of sulphur and rubber in oil of turpentine, it occurred to him that as the melting point of sulphur was only about 240 deg. Fah., it would be worth ascertaining the result of immersing sheet rubber in sulphur at the lowest melting point. "I accordingly melted some sulphur in an iron vessel and immersed some slips of cut sheet rubber about $\frac{1}{2}$in. wide and about $\frac{1}{16}$in. thick. After they had remained some time I examined them and found that the surface had assumed a yellowish-tan colour. I immersed them again, and on withdrawing them a second time I cut one of them across with a wet knife and found that the rubber was tinged of this tan colour to a considerable depth. I immersed them again, and on the third examination I found that the tan colour had quite penetrated through the slip. 'This was strong evidence that the rubber had freely absorbed the sulphur, and I fully expected to find that these slips were now 'changed,' but in this I was greatly disappointed, for on applying the tests I found not the least 'changing' effect had been produced. I now replaced them and raised the temperature of the sulphur and allowed them to remain a considerable time, and on withdrawing one of them the fourth time found to my great satisfaction that it was perfectly changed, retaining the same tan colour throughout." It was now demonstrated that sulphur and sulphur alone blended with the rubber and acted on by heat at the proper temperature for a relative period of exposure to its influence was the sole cause of this extraordinary change. Enrolment of the appendix to Hancock's patent became due on May 21st, 1844, and for some time previous to that date Hancock was at great pains to render his specification complete in all respects. For this purpose he left specimens with two scientific workers (Professor Graham and Mr. Arthur Aikin), requesting them to repeat the experiments, make themselves masters of the modes of operation, and give assistance in drawing up the specification. "I think I might venture to state, not boastfully, that as a matter of fact there is not, to this day, 1856, any document extant, including those referred to in it, which contains so much information upon the manufacture and 'vulcanisation' of rubber as is contained in this specification."

The term "vulcanisation" was not of Hancock's own coining, but was suggested, after Hancock had discussed the matter with numerous acquaintances, by Brockedon.

American Engineering News

Machine Tool Developments

In view of the wild talk about war defence, war profits, and war profiteers in the steel and machinery industries, it is interesting to note that United States trade records show only 20 per cent. of 1938 orders, for machine tools were from the "defence groups," including aircraft and ship-building works and Government Departments. In the past five years from 60 to 75 per cent. of the total orders have been from a group comprising manufacturers of electrical equipment, agricultural implements, engines, pumps, conveyors, printing and canning machinery, and foundry equipment. On the other hand, only 10 to 14 per cent. of the orders—or $6\frac{1}{2}$ per cent. in 1938—were from a group of industries which are little affected by Government expenditures, but are affected severely by the scarcity of investment of private capital. They include construction and mining machinery, railway equipment, textile machinery, steel mills, and forge works. Since the machine tool business has been on the decline for some years, 1939 should be better than 1938, but the task is to convince manufacturers that this trend must be reversed if profits are to be expected. It is an unfortunate condition that, regardless of manufacturing facilities, manufacturers are rarely disposed to make even needed replacements of machine tools unless their order books are filling up. A recent discussion on progress in machine tool electrification covered the use of gear motors to simplify the design, the use of small motors, cost of electric and other drives, flexibility obtainable by modern electric drives, and the use of welded fabrication. An investigation by the National Machine Tool Manufacturers' Association indicates the need of better methods of wiring tools and better selection and application of motors and control apparatus. But manufacturers of the electric equipment must realise that purchasers of machine tools now make more exacting demands on the builders. Work formerly turned and ground is now finished in the lathe, and operations formerly done on three or four successive machines are now combined in one machine and at one setting.

Boulder Dam Power Plant

Although generation of electric energy is only a very secondary purpose of the Boulder Dam, the revenue from this energy is to repay a large share of the cost, and the plant is of exceptional size. All of the energy had been allotted to responsible companies or municipalities in advance, under fifty-year contracts. The total development in the first year will be 4330 million kilowatt-hours, to be reduced year by year owing to diversion of water from the reservoir. The Southern California Metropolitan Water District will take 36 per cent. for its aqueduct pumping plant. The generating plant is divided into four groups, which are entirely separate, and connected to different transmission lines at different voltages, while one of them has a different frequency. Of the seventeen units, two will be of 40,000 kVA, and the others of 82,500 kVA capacity. The power plant is contained in a building U-shaped in plan, with its base against the dam and the two legs extending 650ft. along the side walls of the canyon. The total length is 1650ft., and the floor is 150ft. above tail water level. Turbine pits are provided for fifteen units of 115,000 H.P. turbines and 82,500-kVA generators; also two of 55,000 H.P. and 40,000 kVA. Four 30ft. steel penstocks have each four 13ft. branches, one of them branching again to serve the two 55,000 H.P. turbines. The turbines are of the Francis type, with cast steel scroll cases embedded in concrete, each provided with a pressure regulator valve which may be operated as a water saver or a synchronous by-pass. Control of the turbines is effected by means of oil pressure servomotors under the control of actuators. The main generating units are of the conventional three-section shaft, three guide-bearing type with the thrust bearing above the generator. The speeds are 180 revolutions for the 60-cycle units, 150 for the 50-cycle units, and 257 revolutions for the 55,000 H.P. units. The generator voltage is 16,500 for the 82,500-kVA machines. Three transformers of 55,000 kVA capacity will step up the power of 287,500 volts for transmission 265 miles to the city of Los Angeles.

Standard Specifications for Metals

A large number of revisions and additions to the various metal specifications of the American Society for Testing Materials has been prepared for the new triennial issue of its standard specifications—some 900 in number—to become effective in November, 1939. For steel forgings there are seven classes, ranging from 47,000 lb. to 90,000 lb. per square inch in tensile strength and 25,000 lb. to 55,000 lb. in yield point. New specifications for carbon steel castings suitable for fusion welding have a maximum carbon range of 0·25 to 0·35 per cent., with maximum manganese 0·70 per cent., but manganese increased in relation to reduction of carbon below maximum. For steel pipe and tubing there are nine ferritic grades, with minimum tensile strength of 60,000 lb. and yield point 25,000 lb.; also four austenitic grades of 75,000 lb. minimum tensile strength and 30,000 lb. yield point. New specifications will cover electrically welded steel boiler tubes for high pressure. Steel for boiler rivets is now specified at 45,000 lb. to 55,000 lb. tensile strength, but will be supplemented by a new specification covering 58,000 lb. to 68,000 lb. Cupola malleable iron castings are to have a minimum tensile strength of 40,000 lb., with 30,000 lb. yield point, and 5 per cent. elongation in 2in. A new aluminium base alloy for die castings has 8·3 to 9·7 per cent. aluminium, 0·013 per cent. minimum for manganese, 0·4 to 1·0 per cent. zinc, 0·5 per cent. maximum for silicon, 0·05 per cent. copper, 0·03 per cent. nickel, 0·3 per cent. cadmium and tin, with magnesium for the remainder. A proposed accelerated standard salt-spray corrosion test for non-ferrous metals and alloys will be tried by four co-operating laboratories, each using six kinds of metals in three different solutions—sodium chloride, sodium hydroxide, and sulphuric acid. As a result of numerous tests of farm fencing, barbed wire, and wire strands, revisions are recommended in tests for protective coatings, including electro-deposited coatings on steel, together with new methods of determining the thickness and uniformity of coatings. There will be a report also on the use of chromium-steel and chromium-nickel-steel for architectural purposes.

Chicago City Plan Developments

For some thirty years the City of Chicago has had an unofficial but widely representative City Plan Commission, founded by a leading architect—the late Mr. Daniel Burnham—and having much influence in guiding the city's developments. It has based its studies and recommendations on conditions of a fairly distant future rather than on present conditions. Its work has covered main thoroughfares to facilitate street traffic, parks and playgrounds, and other works incident to industry and public welfare. It is now proposed to establish this Commission as an official municipal body, with authority to carry out its ideas, instead of simply recommending various steps and projects. The scheme provides for including suburban representation on the new Commission, since the affairs and welfare of the city and its surroundings and tributary suburban towns are so closely woven together. A few of these towns have been absorbed by the city, but most of them would not regard any such proposition with favour. The city's water supply from Lake Michigan is pumped to thirty-seven towns which purchase it in preference to developing their own sources of supply. And the sewerage and sewage disposal system serves about sixty outside towns. In area, the city proper covers about 202 square miles, while neighbouring towns in the metropolitan area cover 532 square miles in this metropolitan area of 2640 square miles. In population the city proper has 3,376,500, and the neighbouring suburban and other towns have 1,129,000, while the total for the metropolitan area is 4,643,000. As a considerable proportion of the suburban and territorial population has its business in Chicago, the development of transportation and sanitary facilities is of mutual concern. The city's Plan Commission is supplemented by the "Regional Planning Commission," which deals with an area within about 100 miles radius.

TALYBONT RESERVOIR.—On Thursday, June 29th, the Talybont reservoir was officially opened. This reservoir, which supplies Newport, Mon., was first begun in 1927, and, after work had been deferred for a time, building was recommenced in 1931. It has cost, including pipe lines, &c., over £1,174,000 to build, and has a storage capacity of 2567 million gallons.

A Large Billet-Heating Furnace

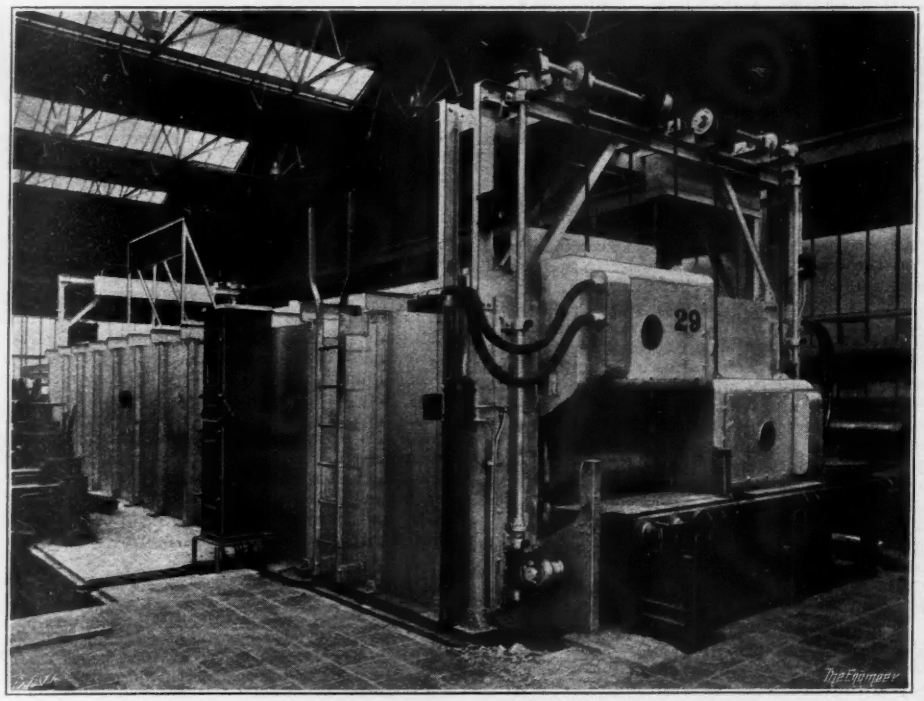
AN electric billet-heating furnace, believed to be the largest of its kind in existence, has been put into service at the works of the Reynolds Tube Company, Ltd., Birmingham, by G.W.B. Electric Furnaces, Ltd., of Belgrove House, Belgrove Street, W.C.1. The furnace (shown in the accompanying engraving) is used in conjunction with a 5000-ton extrusion press, and is capable of handling billets up to 20in. in diameter and 4ft. long at the rate of four per hour. Three other furnaces have been installed in this works by the firm mentioned during the last three years. Rated at 600 kW, the furnace illustrated has three independently controlled zones, the chamber being 39ft. long, 9ft. wide, and 1ft. 10in. high above the hearth. An electrically operated pusher, complete with charging and discharging gear, is fitted. The capacity of the furnace is forty billets of the stated dimensions, each weighing approximately 1650 lb. Air circulation is provided by three patented centrifugal fans.

While a number of pusher type furnaces for billets are already in operation in this country, the furnace under consideration is claimed to offer the advantage that no unproductive weight of metal is heated. Although this is also the case in gravity fed furnaces, the heat losses are said to exceed those of this large pusher furnace, since side doors, which are the main cause of the loss, are needed in the gravity furnace. While the initial cost of the furnace using this patented pusher mechanism exceeds that of the gravity feed furnace, it is less than that of the conveyor type.

The design incorporates the Gibbons-Marchant pusher mechanism used in continuous furnaces for annealing brass and copper components supported in trays. Two heat-resisting rods extend throughout the entire length of the furnace, and are supported at intervals on open "deadeye" bearings. Ears, composed of similar material, are welded to the rods at a pitch which coincides with the diameter of the billet plus the required clearance. A mechanism, using a crank and lever gear for the longitudinal movement, is provided with means whereby the ears, which are normally parallel to the hearth and clear of the billets, can twist through an angle of 90 deg. upwards at the beginning and end of the forward movement, thus conveying each billet one pitch forward with each stroke. The entrance door is mechanically interlocked with the twisting gear, and ensures that the door is clear before charging begins.

In addition to the conveying gear, a simple method of loading the charging table with billets from the floor level is introduced by using the same electric drive during the idle or return stroke of the pusher arms. The interlocking escapement gear enables the charging end of the furnace to be controlled from the discharging end by the press operator without any attention, provided a sufficient number of billets is stocked on the inclined floor.

The charging mechanism embodies a method developed by the makers for use on similar billet-heating furnaces. Each door, the hearth plate, and tilting gear are interlocked, and operated by an electric drive, the push buttons being mounted on the furnace structure. To enable billets 3ft. to 4ft. long to be accommodated, the supporting and guiding beams inside the furnace are stepped to prevent side travel and risk of misalignment. The strip resistor elements are fitted in the furnace roof with the Gibbons-Wild-Barfield patented method of support, which is claimed to ensure a maximum radiation factor and free circulation of air around the elements.



ELECTRIC BILLET-HEATING FURNACE

Fire Engine for Speke Aircraft Factory

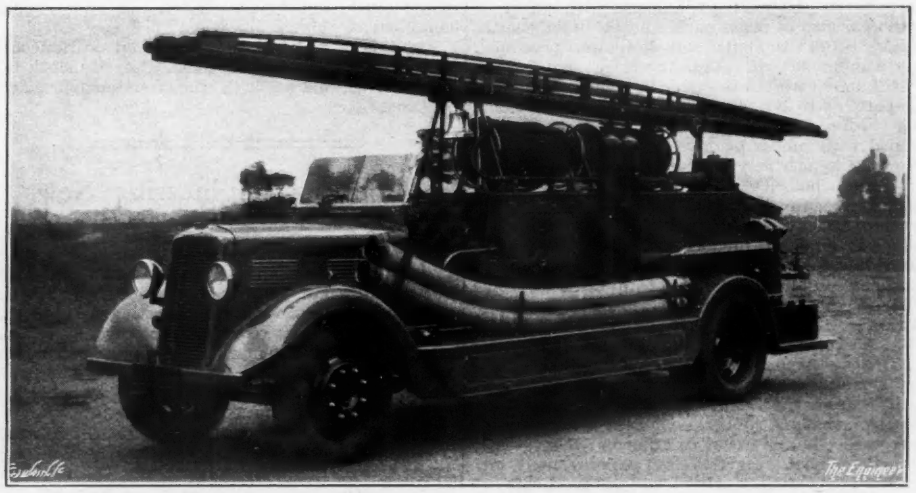
WE illustrate in accompanying engravings a specially designed automobile fire-engine which Merryweather and Sons, Ltd., have recently constructed to the order of Rootes Securities, Ltd., for the protection of the aircraft factory at Speke. The official trials by the technical experts of Messrs. Rootes took place at the makers' works at Greenwich during last week.

The chassis is of a standard "Commer" type with an engine of 80 B.H.P. supplied to Merryweathers from the Luton works of Commer Cars, Ltd., for fitting up with the special units of equipment necessary to meet the conditions obtaining at the Speke factory. These conditions necessitate the employment of foam in the largest possible quantity, together with a supply of liquid CO_2 gas, and a pumping equipment that will boost the pressure on the existing underground hydrant system sufficiently for fire-extinguishing purposes.

In the superstructure of the vehicle there is fitted a galvanised steel tank having a capacity of 200 gallons which is filled with water that is instantly available for delivery through a small diameter rubber hose contained on a hydraulic reel for dealing with outbreaks in their initial stages.

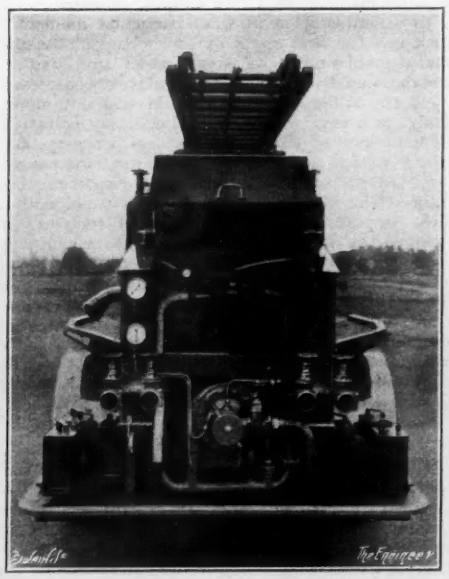
This quantity of water is also available for the generation of foam which is produced on Merryweather's patent "Xaust-Suds" principle. Water from the tank is delivered from the main pressure pump to a Venturi mixing chamber, housed in the rear of the superstructure. Into this mixing chamber there is taken a branch from the engine exhaust pipe, and into it is forced under pressure a supply of concentrated liquid stabiliser from a small auxiliary electrically driven pump operated from the lighting circuit. The foam so generated in the mixing chamber is delivered through two separate outlets for the attachment of ordinary fire hose; 1 gallon of stabilising liquid is claimed to produce 2000 gallons or more of foam. The total quantity of foam that can be made from 200 gallons of water amounts to 2000 gallons, which is distributed constantly at the rate of approximately 400 gallons of foam per minute as long as a water supply from the underground hydrant service is available for filling the tank.

In addition, a total quantity of 200 lb. of liquid CO_2 is carried in four steel cylinders—see the accompanying engraving—giving an output of approximately 1700 cubic feet of CO_2 gas at atmospheric pressure, which is discharged through a separate line of small diameter hose pipe contained on a hydraulic reel terminating in a conical distributor.



FIRE ENGINE FOR AIRCRAFT FACTORY

The fire pump is of the single-stage, centrifugal type, and is driven through a power take off from the petrol motor. It has a total capacity of 500 gallons per minute, sufficient to supply four powerful high-pressure jets simultaneously. A light telescopic ladder is carried overhead and accommodation is provided for a large quantity of fire hose and other articles of fire brigade equipment. The machine is finished in a battleship grey colour. The accompanying engravings show clearly the compact nature of the design and the easy accessibility of the whole of the equipment units.



REAR VIEW OF FIRE ENGINE

RAILWAY ELECTRIFICATION IN YUGOSLAVIA.—The Italian correspondent of the *Financial Times* reports that Italy has arranged a credit of 500 million lire with Yugoslavia to be applied to the electrification of sections of the Yugoslavia State Railways and the purchase of war materials. Negotiations are understood to be in progress for a further Italian credit of 150 million lire for railway equipment to be purchased in Italy.

New Metal-Clad Switchgear at the Clydes Mill Power Station

A NEW 11-kV, 1000-MVA switchboard being installed in the Clydes Mill power station of the Clyde Valley Power Company by the General Electric Company, of Witton, Birmingham, will serve, when it is complete, as a link between the generating plant in that station and the grid and will also form a connection between those sources of supply and the company's distribution system. Ultimately it will consist of two sections, each comprising two units for controlling 30,000-kW alternators, two units for 30,000-kVA transformers, three units for outgoing supplies, and a single unit to couple the two sections of the switchboard together through reactors, as shown in Fig. 1. For convenience in operation the area supplied from the station is divided

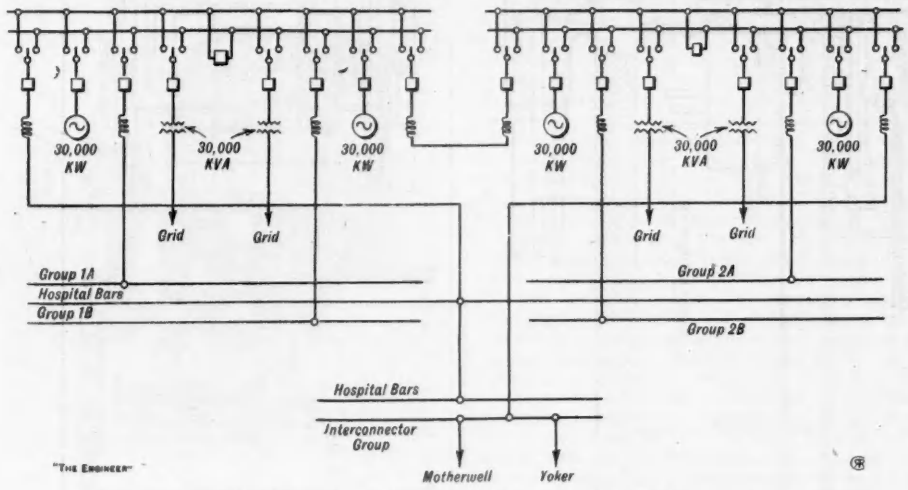


FIG. 1—CONNECTIONS FOR COMPLETE SWITCHBOARD

into four sections, each of which is supplied from one group of an existing 11-kV, 500-MVA switchboard. Each of these groups is connected to the 1000-MVA board through a reactor and one of four of the six distribution units mentioned. The remaining two of the 1000-MVA units control the 500-MVA hospital bars and a 500-MVA "interconnector group" respectively, and from the latter feeders are taken to the Yoker and Motherwell stations.

The nine-unit metal-clad oil and compound insulated vertical isolation board, recently completed, and forming the first section of the complete main switchboard has duplicate sets of bus-bars, solid in each case throughout the length of the board, and each circuit breaker may be connected to one or the other of the two sets by an oil-immersed bus-bar selector switch mounted above the circuit breaker to which it belongs. These switches disconnect the breaker from one set of bars before connecting it to the other set, and are thus not arranged for on-load bus-bar selection. By lowering them vertically the circuit breaker assembly and bus-bar selecting switch may be completely isolated from the bus-bars.

The circuit breakers have a breaking capacity of 1000 MVA at 11 kV, in accordance with B.S.S. 116, Part 2—1937, and proved by a complete series of short-circuit tests carried out on a complete unit, including the whole of the bus-bar structure, the bus-bar selecting switch and current transformers. In Fig. 2 is shown a general view of the board, taken from the floor level, whilst a cross section of one of the units is given in Fig. 3. On the tubular hard-drawn copper bus-bars is wound and baked an insulating layer of bakelite varnish impregnated paper, protected by an outer brass tube. Each bar is composed of a number of sections. There is one less section than the number of switching units in the board, and each section serves as connection between a unit and its neighbour. Joints between the sections are housed in compound-filled chambers, which also serve to accommodate the female plug contacts by which the bus-bar selecting switch is connected to the bus-bars, as shown. This type of bus-bar construction gives effective cooling, while utilising only a small amount of inflammable material for insulating the bars.

The bakelised paper insulation on the bars will not support its own combustion, while the amount of compound is reduced to that in the joint chambers and in the interior of the tubes. Electrical connection between adjacent sections of bus-bar is made by copper fish-plates bolted to the ends of the tubes, without provision for expansion at these joints. The bus-bars enter the joint chambers through packed glands, which allow for relative movement between them and the chambers. Movement of the bus-bars as a whole in one direction or the other is limited by stops, and clearances inside the joint chamber are sufficiently large to allow of this limited movement. Hence there is no possibility that expansion and contraction of the bus-bars arising from variations in temperature may result in the transference of excessive stress to the remainder of the structure.

For the connections between the bus-bars and the circuit breakers plug contacts are provided, each accommodated at the upper end of the spout insulator, which is cemented in turn to the lower end of one of the joint chambers. These plug contacts are connected to the bus-bars by multiple flexible conductors, each consisting of a large number of strands of fine wire laid up into a circular section and wrapped with copper tape to avoid the possibility of a broken strand forming a high stress point or a connection to earth.

For each circuit breaker two sets of three, or six joint chambers in all, are required, and to obtain the advantage of complete phase separation each chamber is entirely separate from the others. Before erection, however, each set of three chambers is bolted and dowelled together in a jig so that perfect alignment between the fixed contacts corresponding to the bus-bars and the moving contacts correspond to the bus-bar selecting switches is assured. At the lower ends of the spout insulators are automatic shutters, which close and prevent access to the live contacts when the circuit breaker and its selecting switch are withdrawn from connection with the bus-bars.

Forming part of the fixed portion of the unit and accommodated above the circuit breaker and behind and below the rear bus-bars, the cast silicon-aluminium current transformer chambers are filled with "Penetrol" insulating oil. To preserve complete phase separation each unit has three separate chambers. One end of each chamber terminates in a downwardly directed spout, in which is mounted a female plug contact similar to those on the bus-bars, with which the rear contacts of the circuit breaker engage. The rear end of the current transformer chamber is prolonged by a link chamber and bushing insulators passing through the wall behind the switchboard into the cable dividing boxes on the opposite side. Complete separation between the space containing the cables and that containing the switchgear is thus obtained. Each phase of the outgoing cables consists of three separate single-core cables, and the purpose of the links in the link box behind the current transformer chamber is to enable any one of the three cables in any phase to be isolated from the others and earthed, so that it may be repaired without the necessity of putting the others out of service.

The potential transformers are accommodated behind the bus-bars in oil-filled tanks which may be withdrawn in an upward direction by means of the switchroom crane. As the potential transformer is raised it is isolated from the conductor in the current transformer chamber. The isolating contacts are carried by bushing insulators passing through the bottom of the potential transformer tank and through apertures provided for the purpose in the top of the current transformer chamber. When the potential transformer is withdrawn these three apertures are closed by hinged covers. The potential transformer fuses may be renewed while the unit is in service without withdrawing the potential transformer itself.

Each bus-bar selecting switch is accommodated in a cast silicon aluminium chamber mounted on the upper side of the circuit breaker top plate (Fig. 4). The upper part of the chamber carries six bushing insulators, terminating in the male plug contacts, which engage with the female contacts in the bus-bar spout insulators. At their lower ends these bushings carry sets of finger contacts. The circuit breaker bushing insulators pass through the circuit breaker top plate into the lower part of the selecting switch chamber and each bushing carries a casting to which are fixed two sets of finger contacts, corresponding to the two sets of the upper terminals. Each switch blade consists of four vertically disposed hard-drawn copper bars mounted on insulators and guides, in such a way that they can be moved backwards and forwards horizontally, and thus caused to engage with the contacts appertaining to the rear or front bus-bars as desired. In common with the remainder of the gear, the bus-bar selecting switch chamber is divided into three separate compartments to give complete phase separation. As the switch blades are operated by screw gear driven by a small electric motor, transference of the connection from one set of bus-bars to the other can be effected by remote control. Suitable auxiliary switches are provided for limiting the travel and for indicating in the control room the position of the selecting switches. Mecha-

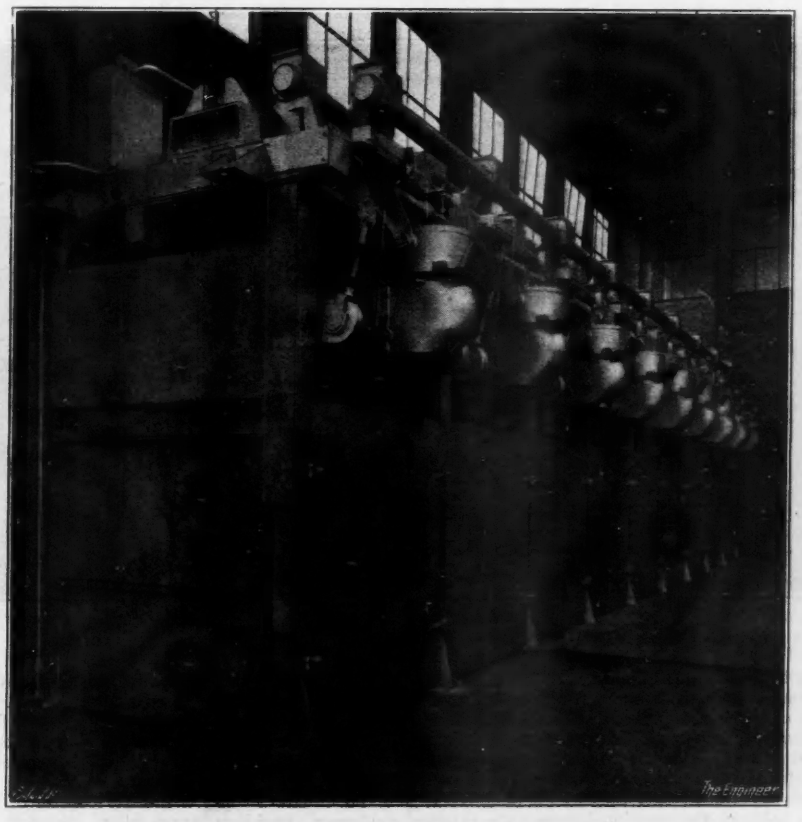


FIG. 2—NINE-UNIT METAL-CLAD SWITCHBOARD

nical position indicators and emergency hand-operating gear are also provided.

Each circuit breaker (Fig. 6) consists of three portions: (1) a massive rolled steel top plate, which carries the bushing insulators, the operating link work for moving the contacts, and the contact guides; (2) a heavy steel tank bolted to the underside of the top plate with three separate compartments divided by steel interphase barriers, phase separation being thus provided inside the breaker; and (3) the solenoid operating mechanism mounted in a fixed position on the framework in front of the bus-bar supports. By means of motor-operated lifting screws the circuit breaker and bus-bar selecting switch assembly may be raised and lowered. The drive from the solenoid to the breaker mechanism is effected by means of chains on either side of the circuit breaker, the solenoid acting through a trip gear upon a shaft extending the full width of the unit. Together with the solenoid, this shaft is slung from the structure, so that it can swing slightly in a direction from the back to the front of the unit, and has keyed to it at either end a chain sprocket wheel, which, together with the chains and the driven sprockets, are housed in two heavily ribbed cast aluminium chain cases, serving to take up the reaction between the driving and driven shaft upon the breaker.

The driven sprockets carry slotted discs which engage with dogs mounted upon the ends of the circuit breaker main shaft, which drives a toggle mechanism imparting a true straight line motion to the moving contact rods, and while ensuring a light tripping motion provides the great power necessary to overcome the electromagnetic forces experienced when the breaker is closed on a fault.

Upon the breaker being lowered to the isolated position, the rear ends of the chain cases follow the breaker's movement, while the solenoid swings slightly from the vertical and takes up the horizontal movement of the front ends of the chain cases. Hence the breaker may be operated both in the isolated and service positions without adjustment of the operating gear. Interlocks operating on the trip-free solenoid mechanism prevent the breaker being closed when it is in any intermediate position. Upon the breaker being lowered below the isolated position, any further movement of the chain cases is arrested, and the dogs on the breaker-operating shaft slide away from the slots in the discs attached to the chain wheels, thus leaving the circuit breaker free to be lowered to the floor and removed bodily from the unit.

The circuit breaker terminals consist of bakelite condenser bushings supporting massive tubular contact stems. At the lower end, each bushing carries a casting to which is bolted the side blast arc control pot and the main fixed contacts. By means of synthetic varnish impregnated paper insulators, the moving contacts are hung from steel lifting rods. These contacts are high-conductivity copper castings bolted to hard-drawn copper bars, and have appropriately disposed wedge-shaped surfaces, which engage with the fixed contact fingers. The moving arc contacts are composed of steel and carry at the upper ends tips composed of a special heavy alloy attached to the extremities of the contact bar. The fixed arc contacts inside the pots are also tipped with this alloy, which was evolved by the G.E.C. By the use of this alloy the amount of burning by the very heavy making and breaking current (136,000 and 52,000 amperes respectively) is reduced to relatively small proportions. By means of G.E.C. side-blast control pots (Fig. 6), the arc which occurs when a short circuit is interrupted is quenched with great rapidity and certainty.

The bus-bar structure and circuit breakers are supported by a series of pedestals composed of welded plates and rolled sections. A pedestal occupies the space between each pair of adjacent units, and as neighbouring pedestals are connected together by stout bearers, which support the bus-bars, current transformer chambers, and solenoids, a very rigid

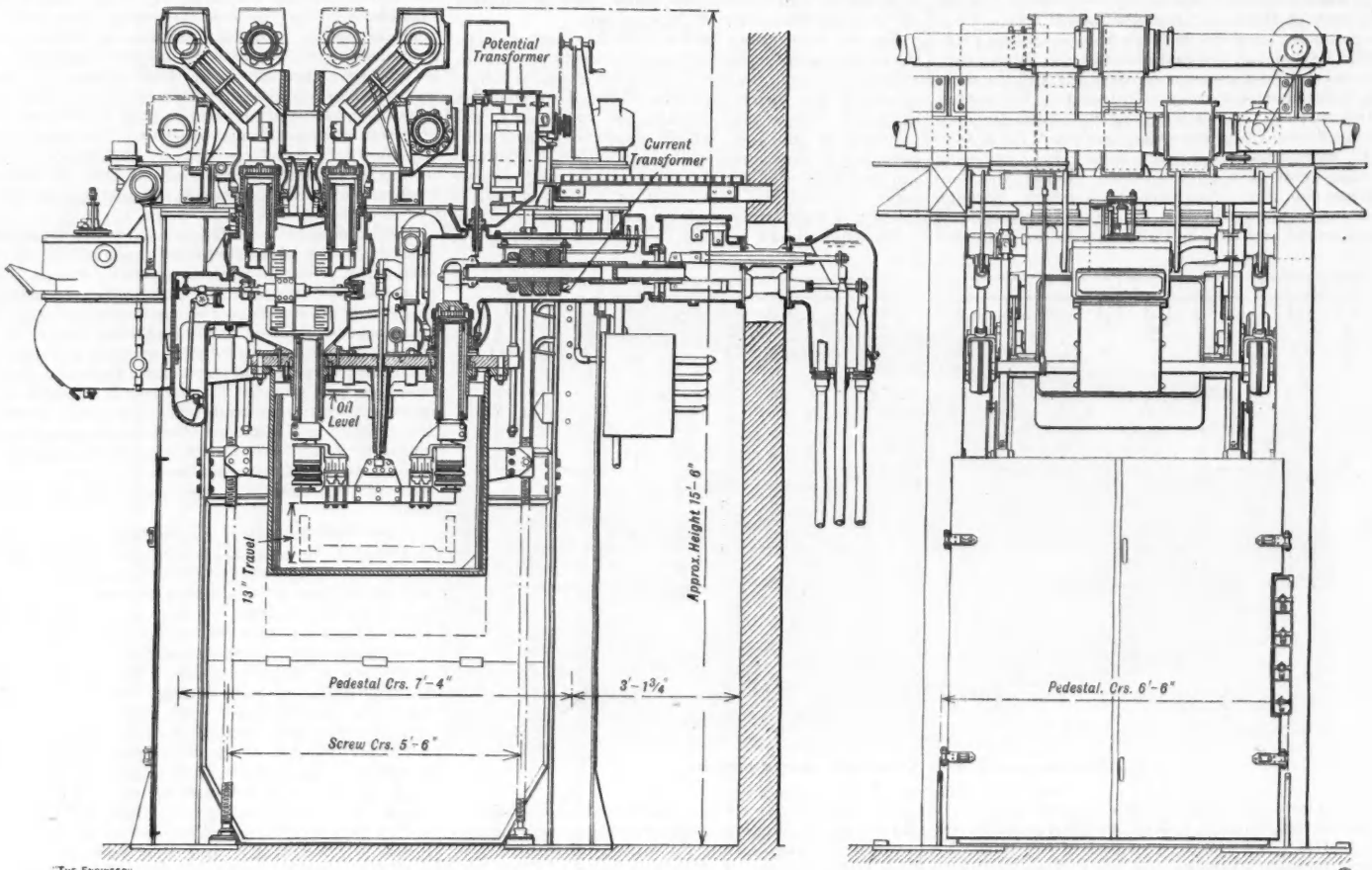


FIG. 3—SECTION AND ELEVATION OF SWITCH UNIT

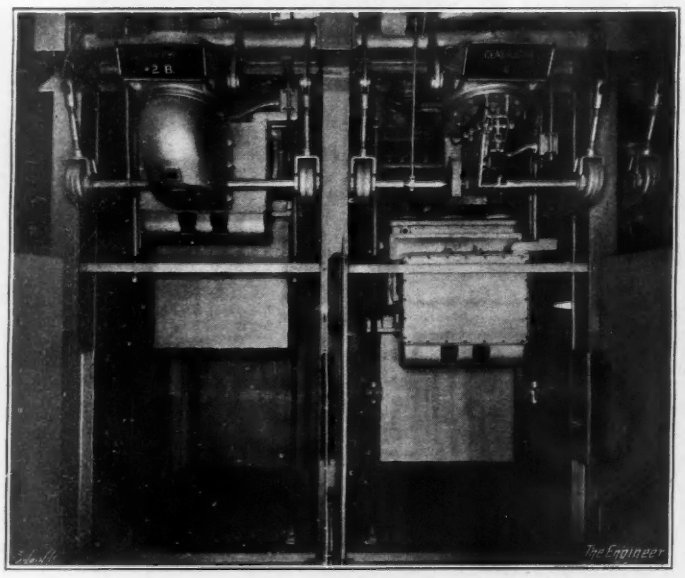


FIG. 4—INTERIOR OF SWITCH UNITS

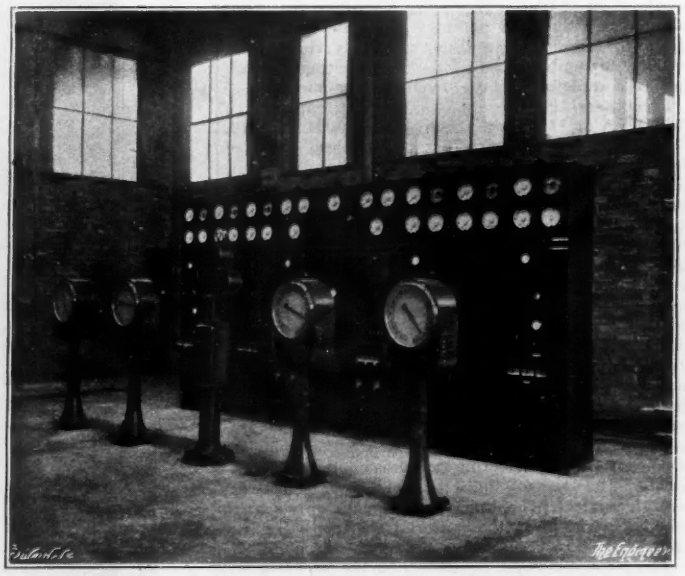


FIG. 5—CONTROL BOARD

assembly is obtained. As the spaces at the rear between the pedestals are filled with steel plates and the webs of the pedestals are solid, each breaker is accommodated in a separate cell, the front of which is closed by doors.

The circuit breaker hoist gear hung from the pedestal consists of four lifting screws carrying two beams secured to the circuit breaker tank. The lifting screws are held in tension. They are hung from the framework through universal joints, and are driven by an electric motor through gearing and an endless chain. Emergency hand-operating gear is also provided. As it is raised from the isolated to the service position, the breaker is guided by four rods attached to the fixed part of the gear. When it is desired to inspect the interior of a unit or renew contacts, the circuit breaker top plate may be hung from these four rods and after the tank fixing bolts have been removed the tank is lowered away from beneath the top plate.

A gangway catwalk runs along the top of the board

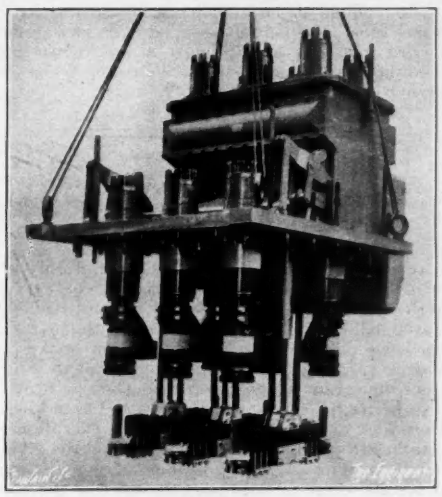


FIG. 6—CIRCUIT BREAKER

against the rear wall, and permits access to the potential transformers, the contactors for the solenoid, and hoist gear, the cable link chambers, and the hoist motors. The circuit breaker and bus-bar selection switches are controlled from the control board (Fig. 5), which also accommodates instruments, relays, and indicating lamps.

It will be obvious from what has been said that the design of the switchgear is such as to avoid as far as possible the risk of damage by fire. The amount of inflammable material in the switchboard has been reduced to a minimum, particularly by the use of condenser bushings as bus-bars. In addition, heavy steel divisions are provided between adjacent units and at the back and front of each unit, and arrangements are made for the rapid draining of any oil that might fall to the floor. Finally the precaution of terminating all cables outside the switch-house first of all minimises the possibility of trouble in a faulty cable box spreading to the rest of the board, and, should fire occur in the switch-house, would prevent the cables themselves from being involved.

The Society of Friends of the Hamburg Tank*

THE recent meetings of the Gesellschaft der Freunde und Förderer der Hamburgischen Schiffbau Versuchsanstalt, held in Hamburg and Berlin from June 13th to 20th, were attended by approximately 1000 delegates, including guests from twenty-two foreign nations.

The meetings were opened on Tuesday, June 13th, at the University in Hamburg, by the President of the Society, Professor Dr. W. Fischer, who delivered an address of welcome to the foreign visitors. It was followed by an historical survey by Dr. Ing. G. Kempf, the Director of the Hamburg Tank, who described the development of experimental work in shipbuilding, and the large number of model tanks which had been founded in many countries to meet the ever-increasing demand for research work on shipbuilding problems. Dipl. Ing. W. Süchting, shipbuilding director of Messrs. Blöhm and Voss, followed with a paper dealing mainly with the application of the bulbous bow to fast passenger ships and similar vessels, and showed how it had been possible to evolve an improved bulbous bow giving reduced resistance in smooth water combined with good sea behaviour in heavy weather. Dr. Ing. E. Foerster, then presented a report on the results of research work carried out at the Hamburg Tank during the past year as part of the new research programme of the Gesellschaft der Freunde und Förderer (G.F.F.). This report took the form of two short papers, dealing respectively with "Improved Hull Forms for Large Fast Passenger Vessels, with special reference to Performance in Heavy Seas," and "Fixed-shroud Propellers."

The first of these papers dealt mainly with experiments on several models of a large fast passenger vessel suitable for the North Atlantic service, from the results of which it was anticipated that by the adoption of a five-screw arrangement, with each propeller transmitting about 42,000 S.H.P., it should be possible to avoid cavitation up to about 35 knots. It was also proposed to adopt three rudders in order to secure improved steering qualities. An excellent cinematograph film was also shown illustrating the behaviour of two self-propelled models of a large passenger vessel with different bow forms, including one with a bulbous bow and fine upper water lines. The manner in which the water was thrown upwards in each case, as the models pitched on encountering regular series of waves in the Tank, was clearly demonstrated.

The second paper was concerned with experiments on models fitted with the well-known Kort nozzle (or fixed shroud) in way of the propeller. The results of these experiments showed the influence of the Kort nozzle on propulsive efficiency at different ship speeds, and also for a wide range of engine revolutions. It was indicated that by the adoption of this arrangement, in conjunction with suitably designed propellers, it should be possible to avoid the loss of propulsive efficiency normally associated with increased engine revolutions. An interesting and novel application of the Kort nozzle principle to tug design was also discussed. This was a twin-screw arrangement with the propellers working in two nozzles situated at the forward part of the vessel, *i.e.*, one on each side of the bow. Several diagrams derived from the model tests were shown on the screen, and it was pointed out that the improvement obtained by this system of propulsion becomes progressively greater as the distance between the tug and the vessel towed is diminished, thus eliminating the disadvantage of the short tow rope.

Following a luncheon at the St. Pauli Fährhaus, a trip round the harbour was arranged for the visitors and ladies. During this trip the shipyard of Messrs. Blöhm and Voss was visited by a number of the guests, who were shown round the various workshops, including the joiners' and carpenters' shops and the platers' shed. Several vessels on the building berths were also inspected, and the visitors were shown a number of examples of fabrication by welding processes. In the evening, a reception dinner and conversazione was held at the Hotel Atlantic in Hamburg.

On the second and third days of the meetings a round trip was made on the ms. "Königin Luise," an 18-knot vessel designed to carry 2000 passengers between Hamburg and Westerland, in the island of Sylt. During the trip the vessel passed by the entrance of the Kiel Canal and called at Cuxhaven and the islands of Heligoland. Demonstrations were given on board of the pitot-tube type installation for continuous measurement of ship speed and also of the Siemens anti-rolling tanks, which appeared to work very satisfactorily. Parties were later conducted round the engine-room and were shown the working of the anti-rolling tank mechanism, which consists essentially of a gyroscopically controlled air pumping system, which blows water alternately from two tanks, arranged one on each side of the vessel.

Friday, June 16th, was the twenty-fifth anniversary of the Hamburg Tank, and meetings were held at the Tank during the morning and afternoon for those specially interested in hydrodynamic problems.

At the morning meeting the first paper was presented by Dr. Lerbs, who described recent improvements in the cavitation tank at Hamburg, including modifications to the tunnel structure to avoid flow breakdown, and details of a new and improved device for torque measurement. Comparisons were also made between experimental results recently obtained in the Hamburg cavitation tunnel, and those obtained in similar tanks in other countries. This paper was followed by a contribution by Dr. Baumann, describing the results of some interesting experiments on the question of the equivalent mass moment of inertia of rotating ship propellers, which were undertaken with a view to obtaining further information regarding the appropriate value to be allowed for entrained water in routine vibration calculations.

The third paper was presented by Dr. Kempf, the Director of the Hamburg Tank. He discussed the results of the full-scale propeller experiments on the ss. "Tannenberg," where careful measurements of thrust and torque were made for both the ahead and astern conditions. In general, the full-scale results confirmed the tank test figures, and the experiments furnished very interesting information regarding several outstanding technical problems in relation to scale effect, roughness, &c.

At the conclusion of this paper, Mr. Troost, the Superintendent of the Dutch Tank at Wageningen, made a speech of appreciation on the occasion of the twenty-fifth anniversary of the Hamburg Tank, and referred to the excellent work which Dr. Kempf had already carried out on the important problem of scale effect and the relationship between model tests and the full-scale results obtained in service.

Ing. H. Schmierschalski then presented a paper on the performance of two or more propellers fitted one behind the other on the same shaft, and turning in the same direction with the same revolutions. As a result of the experiments, it was found that when a fixed guide blade arrangement suggested by Dr. Kempf was arranged between the rotating propellers, it was possible to obtain slightly higher efficiencies than for the usual single-propeller arrangement, and at the same time to reduce the danger of cavitation. The author claimed that this new system was particularly suitable when the propeller diameter was restricted, and also for fast surface craft.

At the afternoon meeting papers were presented by Ing. E. Heckscher on "Experiences Related to the Form of Sea-going Vessels"; Dr. W. Graff, on "Self-propelled Steering Trials," carried out in the new large steering tank at the Hamburg Tank; and by Ing. K. Helm, on "The Effect of the Breadth and Depth of Canals on Ship Resistance." Two further contributions were presented by Dr. H. Kühl and Captain L. Schubert, on the questions of "The Relationship Between Service Routes and Marine Growth" and "The Effect of Marine Growth on Ship Speed," respectively.

During the progress of these meetings visitors were conducted round the Tank buildings, including the large main model experiment tank, the outdoor steering trial tank, and the cavitation tunnel, and were shown the various measuring devices employed, together with the methods by which the various models are prepared. In the evening an official reception and dinner was held in the Uhlenhorster Fährhaus in honour of the foreign guests.

On Saturday, June 17th, visits were paid to Kiel, where the guests were officially welcomed on behalf of the German Navy, and several naval vessels, including one fitted with Voith-Schneider propulsion, were inspected, whilst the ladies and those not taking part in the Kiel visit, proceeded to Malente-Gremsmühlen, *via* Lübeck and Travemünde. From Malente the party travelled to Berlin, arriving there on Sunday evening, June 18th.

Monday, June 19th, was the day of the Lilienthal-Gesellschaft für Luftfahrtforschung (*i.e.*, the Aeronautical Society) and during the morning a party of about one hundred men visited the German Aeronautical Research Station (D.V.L.) in Berlin whilst others attended a lecture at the Haus der Flieger on "The Present Position and Future Development of Trans-oceanic Flying." Following a luncheon at the Berlin airport, the guests were taken over the buildings of the enormous new Tempelhof Berlin air terminus, which is expected to be completed in 1941, and later small groups of visitors took short flights over Berlin. In the evening a dinner was given to their guests by the Lilienthal Gesellschaft at the Haus der Flieger, whilst the ladies were invited to an evening at the "Scala" Theatre in Berlin.

The final day of the meetings—Tuesday, June 20th—was the day of the Schiffbautechnischen Gesellschaft (German I.N.A.), and opened with an address of welcome by the President at the Technischen Hochschule in Charlottenburg. Then followed an excellent paper by Professor Dr.-Ing. G. Schnadel, on "New Experiments on the Tensile Strength of Riveted Joints Employed in Shipbuilding," which was illustrated by lantern slides showing full-scale tests on two riveted plate structures, each representing three strakes of plating, the riveted connection under test being arranged in the middle strake in each case.

Strain measurements were taken under various loads, by means of a large number of meters disposed on each side of the plating, thus furnishing a complete history of the behaviour of the joint and the surrounding plating, up to the load at which fracture finally occurred.

Visits of inspection were then made in three groups to Messrs. Siemens' works in Berlin, to the General Electric Company (A.E.G.), and to the Berlin Tank.

Visitors to the Tank were shown experimental lay-outs designed for special investigations relating to civil engineering projects, such as improved coastal erosion protection schemes, lock entrances and weirs, and also the work of the Shipbuilding Research Tank.

Specially interesting exhibits were a large-scale model arranged for the study of self-sustained vibrations of weirs which could be set in continuous and violent vibration by slightly disturbing the steady flow of water; a series of propellers chemically marked to show the nature of the flow at the surface of the blades; and improved equipment for thrust and torque measurements in connection with self-propelled model tests.

At the conclusion of the meetings a farewell dinner was held in the reception rooms at the Zoological Gardens in Berlin on Tuesday, June 20th, during the course of which members of the many foreign technical societies and institutions represented expressed to Dr. E. Foerster, who organised the meetings, and also to the various German technical societies their lively appreciation of the extremely kindly reception accorded to the foreign guests, and of the interesting and instructive visits which had been arranged.

Copies of the various papers read during the course of the meetings are not yet available, but it is anticipated that a single volume embodying them and the discussions will be published within the next four months.

* Eighteenth general meeting.

The Institution of Gas Engineers

THE seventy-sixth annual general meeting of the Institution of Gas Engineers was recently held at the Institution of Civil Engineers and was attended by about 2000 members and visitors. The record attendance may have been due to the circumstance that the meeting was a commemorative one, inasmuch that it was held in celebration of, and as a tribute to the memory of, William Murdoch, the inventor of gas lighting. His death occurred 100 years ago on November 15th, 1839, when he was eighty-five years of age. It is interesting to state that at the luncheon given by the President, Mr. Robert Robertson, M. Inst. C.E., on the opening day of the meeting, a great-grand-niece of Murdoch, Mrs. Jean Crichton Cullen, was present.

After the customary introductory business and speeches, a Symposium was presented, without discussion, on "The Gas Industry Overseas." It gave a succinct idea of the origin and of the development of the gas industry in other countries, and consisted of a series of short articles by eminent representatives of the industry overseas. The past, present, and future were dealt with.

The seventy-sixth annual report and accounts were then submitted, and Mr. Walter T. Dunn, M. I. Mech. E., former Secretary of the Institution, took the opportunity to make the suggestion that steps should be taken for the erection of some suitable memorial in London to the great Murdoch, to whose talent and inventive genius the world owed so much. Mr. Dunn had ascertained that the authorities of Westminster would be prepared to discuss the possibility of placing a stained glass window in the Abbey, providing the necessary funds were forthcoming from the gas industry. After the adoption of the annual report it was announced that Mr. George Dixon, B.Eng., M. Inst. C.E., Chief Engineer to the Gas Department of the Nottingham Corporation, had been elected President for 1939–40.

In his Presidential Address, Mr. Robertson referred to the suggestions made for improving the existing district organisation of the industry, and the use to which it is put. One was that there should be more intimate collaboration between the committees of the district associations and the district committees of the other national bodies; another that a district technical service might be provided for production and distribution on lines similar to that of the industrial gas development centres, an organisation which is doing good work in a very efficient way.

Referring to education and training, the President remarked that, while parallel courses were provided in manufacture and supply, there was no recognition of the enhanced value of the double qualification, nor is there any incentive to obtain it, since either alone is accepted by the Institution as sufficient educational qualification.

After the address the Murdoch Centenary Lecture was delivered by Dr. E. F. Armstrong, F.R.S. In it he paid tribute to the founders of the gas industry—Murdoch, Clegg, and Winsor. There is no doubt that the information collated by the lecturer will prove of great value to those interested in the early struggles of the industry.

On resuming the meeting in the afternoon, a paper on "The Test Installation of Static Vertical Retorts at Croydon Gasworks" was given by Mr. Walter Grogono, M. I. Mech. E., engineer to the Croydon Gas Company, and Mr. T. Campbell Finlayson, M.Sc., deputy technical director, the Woodall-Duckham Companies, London. This paper set out the results of three years' work, and was to be regarded as an interim report. It gave an account of the operations carried out at Croydon from April, 1936, to October, 1938, when the plant was shut down at the completion of the experimental programme. During the whole of the period all the manual work was carried out by retort-house employees as part of their normal duties. Shift-supervising staff was provided by the Woodall-Duckham Company. Thus, from the commencement, the plant was treated as a normal carbonising unit, subject to normal attention.

The remaining paper on the first day was one on "Distribution and Sales Organisation," by Mr. Noel S. Smith, distribution engineer to the Bristol Gas Company. It dealt specifically with the distribution and sales activities of the Bristol Gas Company. A striking fact brought out was that at Bristol there is only one showroom, contrary to the general practice throughout the country. In lieu of district showrooms, permanent displays are arranged on traders' premises. For canvassing in Bristol, use has been made of selected fitters, but the author explained that in order to increase the numbers it will be necessary to look elsewhere.

An important report on the proposed establishment of a gas research board, presented by Mr. Harold C. Smith, followed. It foreshadowed extensive co-operative research. His remarks were endorsed by Mr. E. V. Evans, Chairman of the Research Executive Committee of the Institution. The objects of the board would be: (*a*) To promote and finance research and other scientific work in connection with the gas industry; (*b*) to establish and maintain a bureau of information for the benefit of members of the board; (*c*) to encourage the discovery of inventions, improvements, processes, materials, and designs which seem capable of being used by members of the board; (*d*) to co-operate with, become a member of, or otherwise assist, the research work of any association, institution, or other body whose objects include scientific or industrial research in connection with or of interest to the gas industry; (*e*) if and when considered desirable, to establish and equip laboratories, and to pay research workers, whether in such laboratories or elsewhere, for the conduct of research; (*f*) to prepare and issue detailed reports for the confidential use of members of the board.

Sir David Milne-Watson had consented to become first President of the board, and it is intended to appoint a full-time Director of Research. One of his first duties will be to set up a bureau of scientific and technical information. It is not intended that an immediate application should be made to the Department of Scientific and Industrial Research for financial aid. The idea is to prove that the success of the board is assured before asking for a grant. Practically every gas undertaking, and the majority of plant manufacturers, will be members of the board.

Mr. E. V. Evans, in the course of his comments on the scheme, said: "There will be available for their use and help a Council, a Director, and a Bureau of Information. Such an organisation must, if well administered, have the effect of enhancing the scientific basis of our industry. We believe that by maintaining a central organisation to investigate problems of a fundamental nature, and by ensuring that the new knowledge thus made available is communicated to members, the undertakings and manufacturers will be better placed to carry out investigations themselves with the object of applying the new knowledge to their own special problems. We hope too, that the offices of the board may become a central clearing house for those problems which are of too wide a scope to be solved locally, and for observations made in one place that may have a wider sphere of application."

In the evening of the first day the usual reception was given, and was numerously attended by members and guests of the Institution. It was held at Grosvenor House.

On resuming on the following morning, Dr. Harold Moore, Director, and Mr. E. A. G. Liddiard, Assistant Research Superintendent, of the British Non-ferrous Metals Research Association, gave a paper on "Non-ferrous Metals and the Gas Industry." The authors explained that, apart from corrosion resistance, the individual non-ferrous metals have characteristics favouring their use in particular applications in the gas industry, especially in gas distribution and consumption. For example, aluminium, with its high reflectivity and resistance to tarnish, is used as a reflector in some types of gas fires and lights, and, in the form of paint, serves to preserve constant temperature conditions in gasholders. Copper is readily fabricated and bent, has a high thermal conductivity, and is easily tinned. It therefore finds application in the form of pipes which can be readily bent or jointed for the distribution of gas. Copper, tinned on the outside where it comes into contact with burnt gas, is extensively used in the construction of gas water heaters. Lead is chiefly remarkable for its ease of working, in addition to its exceptional resistance to certain forms of corrosion. Nickel, when associated with chromium as an alloying element in iron, forms a useful series of heat and corrosion-resisting alloys, and is the best undercoating for chromium-plated articles. The low melting-point of tin makes it useful as a coating metal, or, when alloyed with lead in the form of solder, as a jointing material. Zinc-base alloys can be readily and cheaply die cast to form parts of gas meters, but the main use of zinc is corrosion resisting as a coating to iron and steel.

The next paper was by Mr. L. W. Andrew and Mr. A. Barron, both of the Gas Light and Coke Company, and was on the subject of "Comfort by Gas Heating." It was illustrated by lantern slides. The paper itself considered the extent to which gas can economically provide the maximum comfort in domestic and non-domestic premises. Although the temperate climate of this country makes it possible to use an open fire as the main source of domestic heating, this method alone, the authors suggested, does not give the most economical heating or the most desirable comfort conditions in one room or the whole house. Special reference was made to the open coal fire in the living room.

Central heating by hot water, using gas as the fuel, was considered for domestic and non-domestic premises. The intrinsic advantages of gas compared with solid fuel would often lead to its use in private houses, offices, and blocks of flats, but particularly in large installations. The overall annual cost of heating would be the determining factor.

On the next morning a paper on "Installation of Tower Gas Purifiers" was read by Mr. Cyril M. Croft, M. Inst. C.E., chief engineer and general manager, Wandsworth and District Gas Company. He said the reason for the introduction of this large addition to the purifying plant was due to the fact that, following absorption and amalgamation of other neighbouring undertakings during the previous ten years, it was decided to manufacture as much gas as possible at Wandsworth where the works are situated on the banks of the River Thames, and where coals are delivered direct by seagoing colliers.

The paper described in full the details of construction of the plant, capital cost, method of working, and the financial aspects, both from the capital and economic view-points. The first considerations which determined the choice of this type of plant had in practice been fully justified.

The concluding paper was one by Mr. P. Parrish, F.I.C., manager, Phœnix Wharf Chemical Works of the South Metropolitan Gas Company. In it he mentioned the necessity for combining as much ammonia with sulphur as possible. He said that these minor products of the processing of coal, viz., ammonia and sulphur, would be of inestimable value to this country in time of emergency. They were certainly of economic importance in periods of peace, and their recovery was inevitable in any case. The fact that their production was distributed throughout the country was of notable significance. That Germany attached great importance to the recovery of sulphur was evidenced by the fact that she was enlarging her existing plants to ensure an annual production of 60,000 tons of sulphur from coke oven gas, despite the fact that the cost of production was known to be more than twice that at which Sicilian or Texas Gulf sulphur could be purchased.

Sixty Years Ago

THE KILBURN AGRICULTURAL SHOW

A VERY large proportion of our issue of July 4th, 1879, was devoted to a description of the exhibits at the Royal Agricultural Society's Show, held that year at Kilburn. In spite, however, of the attention which we paid to it we found occasion severely to criticise the Society for its management of the Show. The Kilburn site was an unfortunate choice. It might have been satisfactory had the weather been kindly. As it was, June had proved to be an exceptionally rainy month, and when the Show opened the ground had been churned to a quagmire of mud in some places 2ft. deep. A sketch of a corner of the Show yard which we reproduced showed a litter of abandoned and broken railway lorries still loaded with implements sunk axle deep in the mud and left where the last strenuous efforts of man and horse to move the exhibits into position had failed. In a leading article on the subject we stated that, through mismanagement, what ought to have been the most successful Show ever held by the Society was likely to prove a miserable failure. Throughout the winter considerable expense had been incurred in draining the site in readiness for the Show, but no attempt had been made to provide roadways and footpaths. When the rain came the drainage system proved to be quite inadequate, and before the gates opened the ground was a morass. Even at the last moment the situation might have been partially saved by laying down roadways of planks and old sleepers. The officials of the Society, however, refused to exert themselves, and when certain exhibitors, driven to desperation, sent for planks to lay down round their stands, they were fined 10s. a load for breaking the Society's rules by bringing them into the Show yard. The Society, we feared, had done itself damage by its mismanagement of the Show. It would, we estimated, be £20,000 in debt at the end. In addition, the experience at the Kilburn Show would encourage the desire manifested during recent years by a body of influential agricultural engineers to withdraw entirely from the Society and to hold exhibitions of their own every year or every two or three years in some large manufacturing centre such as London, Manchester, or Birmingham.

INSTITUTION OF NAVAL ARCHITECTS.—A research scholarship of the value of £250 per annum and tenable for two years has been founded by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a Committee of the Institution of Naval Architects, and it is hoped to make the first award in September, 1939. Full particulars of entry, which closes on July 31st, can be obtained from the Secretary, Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

THE COAL INDUSTRY.—The statistical summary for the March quarter of 1939, just issued by the Mines Department, show that the output of saleable coal raised was 59,061,341, as compared with 60,433,952 tons in the March quarter of 1938, a reduction of 1,372,611 tons. The average number of persons employed was 736,960, as against 752,642. The average cost of production was just over 15s. 8d. per ton, an increase of 3¼d., and the average proceeds 17s. 8½d. per ton, an increase of 4¼d. Average earnings per shift, including rent and coal allowances, for all wage earners, including boys and surface workers, were 11s. 10¾d., an increase of rather more than 4d. compared with the corresponding period of 1938. During the quarter 736,960 men worked 50,234,390 shifts, or an average of 5·24 per week. On this basis the average weekly earnings, including allowances, for all workers of all ages, above and below ground, were £3 2s. 3¼d. For all adults, above and below ground, they were approximately £3 7s. 6¼d.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The American Steel Market

The slow development of the American iron and steel market has caused some disappointment, as early in the year it was anticipated that business in 1939 would be on a good scale. Production has fluctuated slightly during recent weeks, but is now at an average of about 54·43 per cent. of capacity. It varies in the different steel-producing districts and in the Birmingham area is as high as 71 per cent., but drops to 47 per cent. in the Pittsburgh district. New buying fails to develop any substance, but compared with the first half of this year the situation is favourable and the tonnage of structural steel and concrete reinforcement bars ordered is higher than during the corresponding period of 1938. One of the worst features of the market has been the rather severe price cutting which has taken place in finished steel, and this has provoked severe criticism by some of the principal trade leaders. The galvanised sheet makers are not well employed, and lately have been operating at about 55 per cent. of capacity. The tin-plate industry is in a fairly good position and is working at about 72 per cent. of capacity, and is expected to maintain this rate as it is meeting the seasonal requirements of the vegetable canners. Anticipations are current that considerable railway business will be placed from abroad. It is expected that a good part of the equipment for a projected railway between Brazil and Paraguay will be bought in the United States. It is also understood that as a result of the visit of Portuguese trade representatives, Portugal will shortly enter the market for rolling stock, to the value of 5 million dollars. In the pig iron market business has declined somewhat of late, but prices are maintained unaltered for third quarter delivery. Considerable interest is taken in the scrap position following large purchases by the International Scrap Convention and by Japan. Prices have advanced to 15 dollars Pittsburgh and 15·50 dollars Eastern Pennsylvania, and at these rates there is a tendency for a larger proportion of pig iron to be used by the steel makers. It is now stated that of the recent purchases of about 5000 tons of scrap by the International Scrap Convention, the greater proportion will be exported chiefly to Great Britain and will be shipped at regular intervals during the last six months of the year. It is stated that since April forty-four ships have been chartered to carry about 270,000 tons of scrap to this destination.

The Pig Iron Market

Conditions in the pig iron market show no material change, and whilst attention is principally concentrated upon the production of basic iron there are indications that the hopes which have been entertained for the past month, that the reduction in the price of hematite which came into effect at the end of last week will bring out considerably more buying, will be realised. In the foundry iron department the only change has been that more buying of supplementary parcels has developed and consumers have found it necessary to add to their contract deliveries and to accentuate the pressure to obtain supplies of material on order. The intensive speeding-up of the rearmament programme is having its effect on all branches of the market and no doubt is responsible for many of the small prompt orders which have been in evidence of late. On the North-East Coast the demand for foundry iron is limited principally to local users, and for a long time past little iron has passed to Scotland, although, in spite of the recent 5s. reduction in the price of Scottish grades, Cleveland is slightly cheaper delivered Falkirk and Glasgow. Midland irons, however, appear to have supplanted Cleveland iron and are about 1s. 3d. below the latter to Scottish users. The make of foundry iron on the North-East Coast is only intermittent, but is sufficient with the stocks in the makers' hands to meet all requirements, although it is said that the reserves are being reduced. The situation in the Midlands is not unsatisfactory, but the worst feature is still the poor request for high-phosphoric grades. Some reports indicate a slight improvement in the light castings industry, but generally the foundries in this department are poorly employed. The demand for low-phosphoric brands on the other hand, has shown signs of fresh expansion recently. Prices are uncontrolled, but in the present state of the market are distinctly firm at £5 10s. to £6 d/d. In the Lancashire market business in pig iron has been moderate in volume and the reduction in the price of Scottish foundry iron has again raised hopes that the English foundry prices will be reduced. Producers, however, deny that there is any likelihood of this. Apart from the foundries employed upon heavy engineering, motor and machine tool work, which use principally low-phosphoric iron, the demand is quiet. In the Scottish market also consumers' requirements are easily filled, but now that the holidays in the Falkirk district have commenced business is likely to be still more restricted. It is too early yet to see the effect of the reduction of 5s. per ton in the price of hematite iron, but judging from consumers' limited purchases during June it seems probable that there will be an expansion in the demand.

The Midlands and South Wales

There has been a slight lull in the placing of new business and specifications are not reaching the works in the same volume as even a fortnight ago. This, however, is not causing anxiety, as the makers realise that it is due to the heavy contracting which occurred in April, May, and June. In any case a decline in business activity normally takes place at this time of the year and is less pronounced than usual this year. In fact, it is just as well that there is some slackening in the demand, since there have been complaints of delays in deliveries, and in spite of efforts which the producers are making to eliminate heavy speculative purchases, consumers are finding it difficult to place orders for execution in reasonable time. Practically all the works have sufficient orders on their books to keep them busy for several months. Huge tonnages of structural steel are passing into consumption and the constructional engineering industry is engaged upon big programmes of Government and other work. It is expected that further contracts for Government buildings will be given out in the not distant future, and there is therefore little likelihood of any slackness in this department for the remainder of this year. The re-rolling industry is busy and is in possession of important contracts for bars and strip. The billet situation is not satisfactory and disappointment is expressed that the recent imports of sheet bars and billets from the Continent have not done more to relieve the position. The home producers of semis, although working at capacity, are gradually slipping behind with deliveries. As a consequence the re-rollers are in a difficult position and in many cases are not able to work to the rate which the orders in hand would justify. Further large imports from the Continent, however, are expected during July and August. The demand for plates continues strong, as the tank, boiler, and locomotive makers are well employed. The shipbuilding industry is also taking heavy supplies. The position of the sheet makers is unchanged. The mills are operating principally upon A.R.P. orders and there is a steady home demand for commercial purposes. Export business, however, is disappointing. In South Wales the demand for all classes of semi-finished steel products is maintained at a high rate. Shipbuilders and constructional engineers are taking heavy quantities of plates and structural steel. There is a noticeable stringency of sheet and tin-plate bars, which is handicapping some of the finishing works. Lately the production of tin-plates has exceeded sales and the orders on the makers' books have been reduced to about 4½ million boxes.

Current Business

A scheme has been put before the Admiralty for the establishment of a plant at Pembroke Dock for the manufacture of copper pipes, and an option on a suitable site has been secured. It is stated that the project is being favourably considered. J. and W. Somerville, Ltd., nail makers, of Caledonia Works, St. Ninians, Stirling, will move their entire establishment to Lennoxtown, where more commodious premises comprising 3½ acres of buildings on a site of 40 acres, known as Lennoxmill, have been bought from the Calico Printers' Association, Ltd. Reconstruction work and erection of buildings and plant, it is estimated, will take from nine to twelve months. The contract for the major part of the steelwork for the new Rolls Royce aero-engine factory at Hillington, near Glasgow, has been received by Redpath, Brown and Co., Ltd., and will be manufactured chiefly at Westburn, Lanarkshire. William Dixon, Ltd., are starting up another blast-furnace on basic pig iron at their Govan Ironworks, Glasgow. James N. Connell, Ltd., steel scrap and machinery merchants, have acquired a site near to their Phœnix and Clifton Works, Coatbridge, for the manufacture of steel barrows. Workshops and offices are being erected at Tinsley Park Road, Sheffield, for the Amalgams Company, Ltd., metal treatment specialists, Attercliffe Road, Sheffield, and Moore and Wright (Sheffield), Ltd., tool makers, are having workshops erected in Rockingham Street. Further extensions have been commenced at the factories of J. H. Fenner and Co., Ltd., power transmission engineers, of Hull. The construction of a large coal-oil plant in Lancashire on behalf of the Government is contemplated in order to provide petrol for the Royal Air Force. John Brown and Co., Ltd., Clydebank, are to receive a contract from the Admiralty for an aircraft carrier of 23,000 tons. The Department of Overseas Trade announces that the following contracts are open for tender:—Indian Stores Department: Supply and delivery of two coke-fired, forced-draught, crucible-type tilting furnaces (Simla, July 17th). New Zealand Public Works Department: Supply and delivery c. and f. Napier of fifteen galvanised steel transmission line towers, complete with arms, ground stubs or footings, and accessories; about 107 galvanised steel transmission line towers, complete with arms, ground stubs or footings, and accessories, supplied and delivered c. and f. Auckland, the towers to be designed to carry a double-circuit, three-phase, 110,000-volt line (Wellington, October 10th).

Copper and Tin

A slight improvement has been noticeable lately in the electrolytic copper market, and although, judging by normal standards, the demand in the United States remains lethargic, more business has passed than during recent weeks. It is a good sign that a number of the independent manufacturers of copper products have been in the market and purchased fair quantities, and in one day it was estimated that transactions totalled 10,000 tons. It is a satisfactory feature that the demand appears to have sprung chiefly from works which are not associated with copper producers, since although the associated works take larger quantities in the usual way, it is generally thought that special arrangements exist with the producers. It is also suggested that the independents became alarmed at the large tonnages of copper which were exported, as disclosed by the May returns. The exports totalled 28,561 tons, compared with 22,629 tons in April. Of the former, Japan took 12,382 tons, the next highest being Italy with 4136 tons, whilst Germany came third with 3054 tons. For the past week trading outside America has not been active, but there has been some buying by the smaller Central European States, and British consumers have bought freely. In fact, the demand from the latter source has for some weeks been one of the most cheerful features of the market. It is noteworthy that the recent request from the Continent has been principally for commercial requirements, and that Government buying appears to have declined. Italian buyers have taken moderate quantities, and Hungary has also been in the market. Japan is reported to have bought fresh quantities direct in the United States. There has been no particular feature of interest in the standard copper market. Speculation has been exceptionally quiet, but the market became a trifle firmer on some covering of bear accounts, probably as a result of the disturbed international situation. . . . The tin market has not developed any special feature of interest, and prices have pursued the expected course and remained at about £230 for cash tin. At times selling at this figure has occurred and has been attributed to the disposal of Buffer Pool stocks, but the tonnages which have been involved have not been large. The May statistics were distinctly favourable, and according to figures published by Mr. W. H. Gartsen the visible supply showed a decrease of 1039 tons from 2381 tons on May 31st to 22,774 tons on June 30th. Mr. Gartsen states that for June and onward his figures will be more complete, and he will publish each month, in addition to the carry-over at the Straits Settlements, the carry-over at European smelters of tin in metal, with the exception of the British Tin Smelting Company, of Litherland. The supplies during June totalled 7630 tons, compared with 8356 tons in May, and the deliveries 8669 tons against 10,117 tons in May.

Lead and Spelter

The most favourable feature of the lead market is the well-maintained demand. At the same time, there seems to be very little surplus metal about, and whilst the producers are apparently willing to meet the market at around present levels they have shown no disposition to press sales. The stocks in this country in London Metal Exchange official warehouses remain steady, and at the end of June amounted to 12,209 tons compared with 12,736 tons at the end of May. On January 31st they totalled 12,856 tons and rose to 13,976 tons in February, the highest point touched this year. Business with the Continent has not been good, but French requirements appear to be expanding. An unusual occurrence at the end of June was the shipment of about 1000 tons of lead from Czechoslovakia to this country. It is a long time since lead was imported from Czechoslovakia, and it is thought that the transaction was connected with an attempt to improve the exchange position. Difficulties in payment due to the disturbed exchanges have for some time obstructed business with Continental consumers. This week the international political outlook has had an adverse influence upon trading in this market, but large quantities of metal continue to pass into consumption in connection with the rearmament programme and also for ordinary commercial purposes. The failure of prices to respond to the good industrial position is attributed to the unfavourable political outlook. The cable and battery makers are actively employed and continue to take steady quantities. . . . The spelter market has developed a rather firmer tone, largely as a result of the activity maintained by the consuming industries of this country. Whilst the galvanised sheet makers are so busy upon A.R.P. shelters, the demand is not likely to deteriorate, and as it is generally understood that this industry will be busy for some months to come, the outlook so far as the consumption of this metal is concerned is distinctly favourable. In the United States the demand has declined somewhat, and the galvanising industry, which is not working under the same stimulus as the British, is not particularly well employed. The Continental demand is also rather indifferent, and it is pointed out that the efforts of Germany to increase her domestic production may have a disturbing influence upon the world market. It is also one of the problems which confronts those producers who are endeavouring to form a new International Zinc Cartel.

Non-ferrous Metal Average Prices

The London Metal Exchange official average prices for June show little change from those for May, but it is satisfactory to note that values in the copper market have at length shown a tendency to advance. The movement was not important, and in the case of cash copper the average was no more than 6s. 6d. higher, whilst for three months it was 6s. 4d. and for settlement 6s. 7d. above the average for May. Wire bars were 9d. better and the average for best selected remained the same as in the previous month. The tin market naturally reflected the higher prices which ruled during June, which sent the average up by £1 8s. 1d. for cash tin and by 16s. for three months metal, the settlement price being £1 19s. 9d. higher than in May. Lead prices generally were better, the average for shipment during the current month being 1s. 8d. more, although for shipment in the third following month it was 6d. down when compared with May. The settlement price was 1s. 4d. higher and the average mean 6d. Spelter prices also showed an improvement upon the May figures. For shipment during the current month a rise of 6s. 1d. is recorded, and for shipment in the third following month of 14s. 3d.; the average mean and the settlement both being 5s. 11d. better than in May. The following are the official London Metal Exchange average quotations for June:—

STANDARD COPPER ...	Cash (mean)	£42	0	5 5/24
	3 Months (mean) ...	£42	7	0 5/12
	Settlement	£42	0	5 5/12
ELECTROLYTIC COPPER	(mean)	£47	19	0 5/24
ELECTROLYTIC COPPER	WIRE BARS	£48	7	6
B.S. COPPER (mean)...	... ...	£47	14	2
STANDARD TIN	Cash (mean)	£227	12	10 1/12
	3 Months (mean) ...	£224	3	2 3/12
	Settlement	£227	13	4 1/12
LEAD — For shipment the current month (mean)		£14	11	3 15/24
LEAD — For shipment the third following month (mean)		£14	13	0 5/24
LEAD — Mean		£14	12	1 23/24
LEAD — Settlement		£14	11	1 7/12
SPELTER — For shipment the current month (mean)...		£14	0	5 5/12
SPELTER — For shipment the third following month (mean)		£14	4	5 23/24
SPELTER — Mean		£14	2	5 23/24
SPELTER — Settlement		£14	0	1 7/12

Current Prices for Metals and Fuels

Makers' official home trade price, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for Empire Markets; for other Markets British quotations conform to Cartel prices.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/-.

	Home.	Export.
(D/d Teesside Area.)	£ s. d.	£ s. d.
N.E. Coast—		
Hematite Mixed Nos.	5 15 0	—
„ No. 1	5 15 6	5 15 0
Cleveland—		
No. 1	5 2 0	5 2 6
No. 3 G.M.B.	4 19 0	5 0 0
No. 4 Foundry	4 18 0	—
Basic	4 12 6	—
Midlands—		
Staffs— *(Delivered to Black Country Station.)*		
North Staffs Foundry	5 1 0	—
„ „ Forge	4 18 0 to £5 0 0	—
Basic	4 12 6	—
Northampton—		
Foundry No. 3	4 18 6	—
Forge	4 15 6 to £4 17 6	—
Derbyshire—		
No. 3 Foundry	5 1 0	—
Forge	4 18 0 to £5 0 0	—
Scotland—		
Hematite, f.o.t. furnaces	5 15 6	—
No. 1 Foundry, ditto	5 3 0	—
No. 3 Foundry, ditto	5 0 6	—
Basic, d/d	4 12 6	—
N.W. Coast— Hematite Mixed Nos.	5 15 6 d/d Glasgow 6 1 0 „ Sheffield 6 7 0 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs and Yorks—	£ s. d.	£ s. d.
Crown Bars	12 5 0	—
Best Bars	12 15 0	—
Midlands—		
Crown Bars	12 5 0	—
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	10 17 6	—
No. 4 Quality	11 7 6	—
Scotland—		
Crown Bars	12 5 0	12 5 0
Best	12 15 0	12 15 0
N.E. Coast—		
Crown Bars	12 5 0	12 5 0
Best Bars	12 15 0	12 15 0
Double Best Bars	13 5 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	12 17 6	—

STEEL.

	*Home.	†Export.
London and the South—	£ s. d.	£ s. d.
Angles	10 10 6	10 0 0
Tees	11 10 6	11 0 0
Joists	10 10 6	10 0 0
Channels	10 15 6	10 5 0
Rounds, 3in. and up	11 10 6	11 0 0
„ under 3in.	11 17 6‡	11 0 0
Flats, under 5in.	11 17 6‡	11 0 0
Plates, ⅜in. (basis)	10 15 6	10 2 6
„ ½in.	11 0 6	10 7 6
„ ⅝in.	11 5 6	10 12 6
„ ¾in.	11 10 6	10 17 6
Un. ⅛in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ⅜in.	11 13 0	11 12 6
North-East Coast—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Plates, ⅜in. (basis)	10 10 6	10 2 6
„ ½in.	10 15 6	10 7 6
„ ⅝in.	11 0 6	10 12 6
„ ¾in.	11 5 6	10 17 6
Un. ⅛in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ⅜in.	11 8 0	11 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 16 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ⅜in. (basis)	10 13 0	10 2 6
„ ½in.	10 18 0	10 7 6
„ ⅝in.	11 3 0	10 12 6
„ ¾in.	11 8 0	10 17 6
Un. ⅛in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ⅜in.	11 10 6	11 12 6

STEEL (*continued*).

	*Home.	†Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ⅜in. (basis)	10 10 6	10 2 6
„ ½in.	10 15 6	10 7 6
„ ⅝in.	11 0 6	10 12 6
„ ¾in.	11 5 6	10 17 6
Un. ⅛in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ⅜in.	11 8 0	11 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ⅜in. (basis)	10 13 0	10 2 6
„ ½in.	10 18 0	10 7 6
„ ⅝in.	11 3 0	10 12 6
„ ¾in.	11 8 0	10 17 6
Un. ⅛in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6

Ireland—f.o.q.—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	10 13 0	10 15 6
Tees	11 13 0	11 15 6
Joists	10 13 0	10 15 6
Channels	10 18 0	11 0 6
Rounds, 3in. and up	11 13 0	11 15 6
„ under 3in.	12 0 0‡	12 2 6
Plates, ⅜in. (basis)	10 15 6	10 18 0
„ ½in.	11 0 6	11 3 0
„ ⅝in.	10 5 6	11 8 0
„ ¾in.	11 12 6	12 10 0
Un. ⅛in. to ⅜in. incl.	11 12 6	11 12 6

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	13 15 0	11-G. to 14-G. 11 5 0
13-G., d/d	14 2 6	15-G. to 16-G. 11 15 0
14-G. to 20-G., d/d	14 10 0	17-G. to 18-G. 12 0 0
21-G. to 24-G., d/d	14 15 0	19-G. to 20-G. 12 5 0
25-G. and 26-G., d/d	15 10 0	21-G. to 22-G. 12 17 6

South Africa, Rhodesia, Nyasaland, £14; Canada, £14 12s. 6d., f.o.b. basis. Irish Free State, £14 15s., f.o.q., 4-ton lots.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	17 5 0
2-ton to 4-ton lots	17 12 6
Under 2 tons	18 17 6

Export: India, £17 15s. c.i.f.; Irish Free State, £17 5s., f.o.q.; General, £15 15s., f.o.b., 24-G. basis.

Tin-plates—
20 by 14 basis, f.o.t., Bristol Channel Ports, 20s. 4½d.
Tin-plate Bars, d/d Welsh Works, £7 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 7 6
„ „ „ tested	7 12 6
Basic (0·33% to 0·41% C.)	7 17 6
„ Medium (0·42% to 0·60% C.)	8 10 0
„ Hard (0·61% to 0·85% C.)	9 0 0
„ „ (0·88% to 0·99% C.)	9 10 0
„ „ (over 0·99% C.)	10 0 0
Rails, Heavy, 500-ton lots, f.o.t.	9 10 0
„ Light, f.o.t.	8 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	4/9½ per lb. (nominal)	
Ferro-Tungsten	4/8 per lb. (nominal)	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 5 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·5 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£16 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/10 per lb. 5/- forward	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton	
Cobalt	8/6 to 8/9 per lb.	

NON-FERROUS METALS.

(Official Prices, July 5th.)

Copper—		
Cash	£42 15 0 to £42 17 6	
Three Months	£43 2 6 to £43 3 9	
Electrolytic	£48 15 0 to £49 0 0	
Best Selected Ingots, d/d Birmingham	£48 15 0	
Sheets, Hot Rolled	£78 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	12¾d.	12¾d.
„ Brazed (basis)	12¾d.	12¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£38 0 0	
	Home.	Export.
Tubes, Solid Drawn 2/1 Alloy	11½d.	11½d.
„ Brazed	13½d.	13½d.
Tin—		
Cash	£229 15 0 to £230 0 0	
Three Months	£224 10 0 to £224 15 0	
Spelter—		
Cash	£14 2 6 to £14 5 0	
Three Months	£14 7 6 to £14 8 9	
Lead—		
Cash	£14 12 6 to £14 13 9	
Three Months	£14 15 0 to £14 16 3	
Aluminium Ingots (British)	£94 (net)	

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	18/- to 18/6
Hamilton Ell	17/6
Splints	20/-
Ayrshire—	
(f.o.b. Ports)—	
Steam	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	18/-
Unscreened Navigation	18/6
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	18/-
Secondary Steam	16/9

ENGLAND

South Yorkshire, Doncaster—	
Steam Hards	19/- to 20/-
Washed Smalls	16/- to 17/-
Northumberland, Newcastle—	
Blyth Best	19/- to 19/6
„ Second	18/- to 18/6
„ Best Small	15/6
Unscreened	17/- to 18/-
Durham—	
Best Gas	19/6
Foundry Coke	26/- to 28/-

SOUTH WALES

Cardiff—	
Steam Coals:	
Best Admiralty Large	23/6 to 24/-
Best Seconds	23/- to 23/6
Best Dry Large	23/- to 23/6
Ordinaries	23/-
Bunker Smalls	16/- to 17/6
Cargo Smalls	15/- to 15/6
Dry Nuts	27/6 to 28/-
Foundry Coke	35/- to 42/6
Furnace Coke	33/6
Patent Fuel	25/6
Swansea—	
Anthracite Coals:	
Best Large	36/- to 38/-
Machine-made Cobbles	41/- to 45/6
Nuts	40/- to 45/-
Beans	33/- to 38/6
Peas	26/- to 30/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large Ordinary	22/6 to 24/6

FUEL OIL.

Inland consumption: contracts in bulk.

Exclusive of Government tax of 1d. per gallon; and 9d. per gallon on oil for road vehicles.

Ex Ocean Installation—	Per Gallon.
Furnace Oil (0·950 gravity)	3¾d.
Diesel Oil	4½d.

French Engineering Notes

(From our own Correspondent in Paris.)

The Railway Reforms

WHEN the National Railway Company took over the working of the entire railway system on January 1st, 1938, its main object was to eliminate the huge deficits that had been accumulating for several years, and it was faced with the problem of carrying on without assistance from the public exchequer, unless funds were voted exceptionally by Parliament. Under the new statutes the company could not rely upon State financial aid. The railways could only be made self-supporting by means of an extensive programme of economy covering all phases of working and administration. The administrative services were centralised and simplified; the errors of the forty hours' week were corrected and redundant railwaymen provided with other occupations; a considerable mileage of unprofitable local lines was abandoned; services on main lines were rearranged with a view to reducing the number of trains without impairing traffic efficiency; and preparations have been made for standardising rolling stock and adopting methods of purchase and construction in a manner to accelerate the building and cheapening the cost and maintenance of locomotives and coaches. As soon as this last part of the economy scheme is approved by the Government the company will put in hand a four years' plan which will enable locomotive and wagon builders to organise their industry for a standardised production of rolling stock. The sooner this is done the better it will be for builders, who have been vegetating for many years. It was not expected that all these and other reforms would take full effect in so short a time, and they have elicited no complaints from railway users, although lorry makers protest against the Government nursing the railways to the disadvantage, they say, of their own industry. The President of the National Railway Company, Monsieur Guinand, states that the receipts during 1938 were 1970 million francs less than the working costs, while in the preceding year the deficit was 2038 millions. It must not be forgotten that the company started last year with an increase in rates and fares. Monsieur Guinand believes that with further economies to be carried out, and a probable traffic increase, the deficit between working costs and traffic receipts will be extinguished in the near future, but the general situation is still overshadowed by heavy financial charges that burden the company. Nevertheless, its remarkable effort of economical organisation has lessened the avalanche of deficits that overwhelmed the old companies when they were not allowed to deal with the problem in their own way.

Raw Materials and Export Trade

Annual reports on the industrial situation presented at this time of the year by associations of manufacturers and producers bring more into conflict the theories of those who regard a favourable balance of trade as necessary for a country's economic prosperity and of others who declare that there can be no salvation without facilities for imports that will promote a more active export trade. The Central Committee of Coalowners never fails to insist upon what can be done by the colliery industry to supply more of the home needs if it is adequately protected by a tightening of import quotas. At a congress held in Marseilles, coal importers made a strong attack on this attitude of coalowners as being dangerous to the national economy. An importation of coal, it was argued, is conducive to activity in exporting industries, and it is in the national interest to encourage the manufacture of quality goods and sell them abroad rather than to overstep the economical limits of raw material production. Those limits are clearly defined in the French coal industry. Since the inquiry in industrial production was carried out towards the end of 1937 it has been recognised that no economic progress can be made without an expanding export trade, and this idea has influenced the present Government in resisting the demands of coalowners for further protection, although considerations of national defence have strengthened the policy of making the fullest use of national fuels. If it were not for the needs created by national defence there would be more freedom for imports that would help to develop the export trade in manufactured goods. To a certain extent this is being done on a basis of exchange. Poland must find a new market for the 7,000,000 tons of coal that were formerly supplied to Austria, and, as already stated, some of it will come into France over a long period of years in payment for electrical machinery and plant.

Shipbuilding

Another instructive report is that of the Chambre Syndicale of shipbuilders, which deals with conditions in the shipbuilding industry in 1938, when all maritime nations carried on severe competitive construction. French builders were confronted with heavy demands for naval armaments and the reconstruction of the merchant fleet, which latter had necessarily to wait its turn, and at present there appears to be little prospect of shipyards being able to push forward with the merchant shipbuilding programme. Recently, further orders were given out by the Minister of Marine for fourteen light surface craft, comprising four destroyers of the "Mogador" and "Volga" type, six 1000-ton torpedo boats and four minesweepers. The orders have been distributed amongst the Chantiers de Bretagne at Nantes, the Ateliers et Chantiers de France at Dunkirk, and the Lorient Arsenal. The Minister has also been authorised to order the construction of a submarine to replace the ill-fated "Phénix." Before the loss of this submarine the Government sought to purchase in the United States diving bells similar to the one used for saving men from the "Squalus," and the United States Naval Department sent the plans instead. The apparatus is being constructed at Cherbourg, Brest, Lorient, Toulon, and Bizerta. While shipyards are so largely occupied with work for the navy the Chambre Syndicale of shipbuilders pleads that while the placing of orders abroad for the renewal of the mercantile fleet may be necessary in present circumstances, it should nevertheless be borne in mind that the abnormal activity in naval construction must come to an end, when French shipyards will need all the work that can be provided by the reconstruction of merchant shipping.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

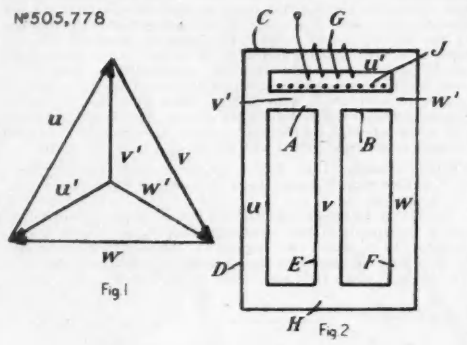
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSFORMERS AND CONVERTERS

505,778. November 16th, 1937.—THREE-PHASE TRANSFORMERS AND THREE-PHASE CHOKING COILS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention is concerned with an arrangement for suppressing harmonics in the magnetising currents of transformers and choking coils. The fundamental system of a three-phase flux is shown in Fig. 1 by the vectors u, v, w. If the three-phase current core shown in Fig. 2 is used with one or both yokes divided into the parts A, B, and C, the limbs D, E, and F carry the fluxes u, v, w, whilst a flux system whose individual flux vectors have the positions u^1, v^1, and w^1 will be produced by superimposing in the slotted yoke parts the flux produced by an auxiliary winding G on the fluxes of the fundamental system. If the lower yoke H is also slotted, an auxiliary winding arranged thereon may produce a flux in phase with u^1 or a flux phase-displaced relatively thereto. The phase position of the auxiliary flux and of the harmonics in the individual yoke parts should be so selected, by suitably dimensioning the cores and yoke cross

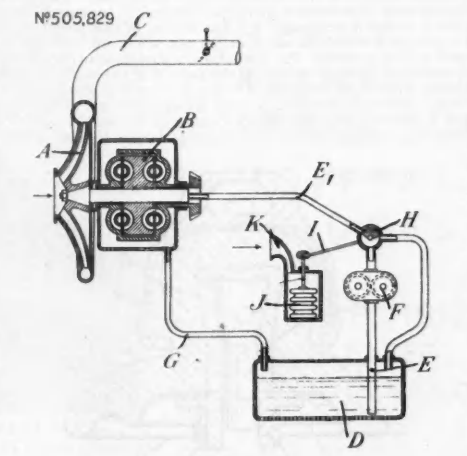


sections and the saturation, that the harmonics of the fundamental system are entirely or partially balanced out as may be desired. According to Kirchhoff's law for magnetic fluxes, the flux components in the common core parts may be ascertained from the following basic equations:—$v^1=u+u^1$, $w^1=v+v^1$, $u^1=w+w^1$. These are shown by the diagram in Fig. 1. The phase displacement of the auxiliary flux relatively to a limb flux of the fundamental system may, for example, amount to 30 deg. If its magnitude then amounts to 58 per cent. of the limb flux $\left(\frac{1}{\sqrt{3}}\right)$, the auxiliary flux u^1 and the two common components v^1, w^1 produce a symmetrical three-phase system, the fifth and seventh harmonics of which are opposed to those of the fundamental system. To ensure a satisfactory distribution of the fluxes between the yoke parts, it is advisable to insert in the yoke slots the short-circuited or squirrel-cage winding J shown in Fig. 2. Several modifications of the invention are also described. —*May 16th*, 1939.

AERONAUTICS

505,829. December 28th, 1938.—AUTOMATIC CONTROL OF CHARGING DEVICES FOR ENGINES, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

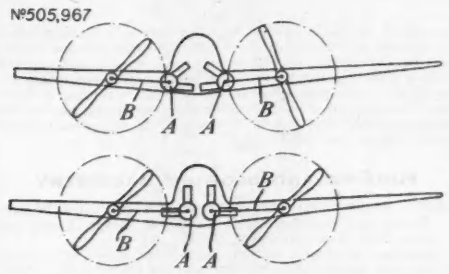
The invention comprises improvements in the automatic control of charging devices for internal combustion engines and is concerned with the driving of a charging blower, particularly for aircraft engines, by means of a hydraulic coupling whose slip or whose liquid inflow and outflow is controlled by a barometric device exposed to the pressure of the outside air. In the example illustrated a blower A is driven by means of a hydraulic coupling B. The latter is driven by an internal combustion engine through a pinion. The engine is charged through the



blower passage C, control of the charging being effected by a throttle. The coupling is connected to a liquid circulation, which may be derived from the engine lubricating oil circuit. The filling of the liquid clutch is effected from a vessel D, which may be the engine oil sump, through a passage E, E_1 by the aid of a pump F. The return passage for the liquid from the clutch is by way of a passage G. Interposed between the clutch B and the pump F is a cock H, which, when turned in the direction for cutting off the passage E_1 from the passage E, at the same time opens a by-pass leading back to G or cuts off the by-pass and opens the passage E_1. The operating lever arm I of the cock is connected to the rod of a barometric device, such as the so-called capsule J. The barometric capsule is incorporated in a housing which has a funnel-shaped inflow opening K. The inflow opening of the funnel is in the wind of travel to which it is directly opposed. The manner of operation of the arrangement described is as follows:—If the aircraft is flying in the vicinity of the ground the barometric device is compressed and the cock H is set so that it opens the by-pass almost completely and the passage E_1 only slightly. Consequently, the largest part of the quantity of liquid supplied by the pump F directly flows back again into the vessel. The smaller part passes into the hydraulic coupling. As a result the slip in the coupling is rather considerable and the blower output is slight in conformity with the greater density of the air at low flying altitudes. As the aircraft ascends the external air pressure acting upon the barometric device is reduced, the device expands and adjusts the cock H into such a position that the by-pass is gradually cut off and the passage E_1 is opened further. Consequently the slip in the hydraulic coupling is reduced and the blower output increases accordingly. However, over the whole range of control the barometric device is acted upon, not only by the surrounding pressure, but also by the dynamic pressure of the wind of travel due to the arrangement of the funnel. If the aircraft flies at a higher speed the dynamic pressure is greater and exerts a greater pressure upon the barometric device. An increasing dynamic pressure reduces the blower output and conversely.—*May 17th*, 1939.

505,967. November 26th, 1938.—ENGINE ARRANGEMENT IN MULTI-ENGINED AIRCRAFT, Walter Blume, Ziesaer Landstrasse 16, Brandenburg (Havel), Germany; and Arado Flugzeugwerke Gesellschaft mit beschraenkter Haftung, Brandenburg (Havel), Germany.

In fitting into an aeroplane an engine with opposed cylinders the engine lies mainly in the interior of the fuselage with parts of its cylinders projecting into the interior of the supporting wings. With this arrangement it is possible to dispense with a gondola for reception of the engine, so that such aeroplanes can be constructed with a low air resistance. This arrangement has,

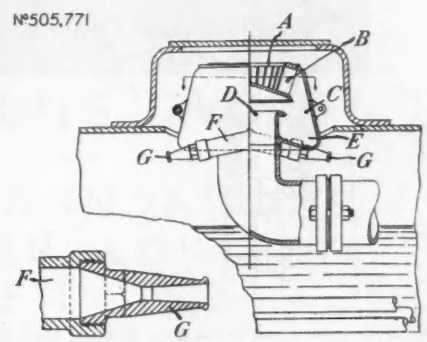


however, only heretofore been possible in single-engined aircraft. In larger aeroplanes and especially in high-speed machines which require two engines or two groups of engines for developing the necessary power, it is difficult to fit the engines within the aeroplane without deforming the profile by addition of gondolas or like structures. These drawbacks are avoided by the present invention, according to which each engine A A is arranged partly within the fuselage and partly within the adjacent supporting wing, the engines being operatively connected by means of transmission mechanism B B with airscrews mounted externally of the fuselage.—*May 19th*, 1939.

LOCOMOTIVES

505,771. November 16th, 1937.—STEAM SEPARATING APPARATUS, Superheater Company, Ltd., Bush House, Aldwych, London, W.C.2; *communication from the Superheater Company, 60, East 42nd Street, New York, United States of America.*

Steam enters the separator at A, passes through the spaces between plates B, being given a whirling or rotary motion by so doing, and enters the space C from which it escapes through the opening D into the elbow to which the dry pipe is connected, and is delivered to the engines, it may be, by way of a superheater. The water separated out from the steam by centrifugal action is thrown against the annular wall bounding the chamber C and gathers and flows around in the lower part E of the separator bowl until it meets a discharge duct F, through



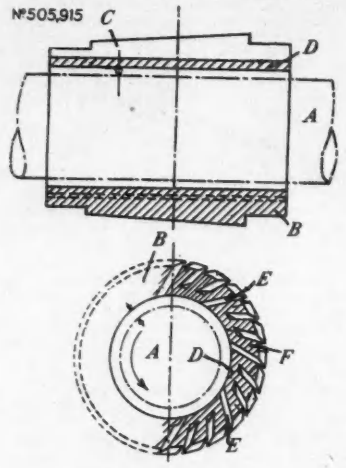
which it is discharged into the steam space of the boiler. With separators of the kind with which the invention is concerned it has proved difficult in the past to discharge the separated water in a satisfactory manner, the difficulty arising partly from the fact that there is only a very slight head available between the point E where the water collects and the water level in the boilers. The portion of a water discharge duct F between the lower portion of the separating chamber and the nozzle G is of substantially uniform diameter, but the portion of the duct formed by the bore of the nozzle has the form of a venturi tube in order that in the divergent portion of the nozzle kinetic energy of the water may be changed into pressure energy and cause the water to overcome the boiler pressure and flow into the boiler steam space.—*May 16th*, 1939.

MACHINE TOOLS AND SHOP APPLIANCES

505,915. November 19th, 1937.—IMPROVEMENTS IN BEARINGS, Josef Volman, of J. Volman, Celakovice, near Prague, Czecho-Slovakia.

The subject matter of the invention is the construction of plain bearing bushes for high-speed shafts, especially for working spindles of high-speed machine tools. The object of the construction is to obtain a rapid temperature equalisation between the shaft and the bush and the necessary freedom for the expansion that is due to the rapid heating without a detrimental effect on the fit and accuracy of the mounting. The shaft A is mounted in the bearing bush B with a certain amount of play. The bush is provided along the periphery with slots or incisions C, which are so deep that a thin ring or cylinder D remains inside. The

ring D is provided with openings E, through which the lubricant is fed under pressure to the play space of the bearing. The bearing bush is fitted accurately into the body of the bearing, the surfaces of the ribs F lying close on the body. The oil forms a lubricating film, the formation of which is specially facilitated when the orifices of the supply openings E are arranged so as to be, as far as possible, tangentially inclined to the direction of

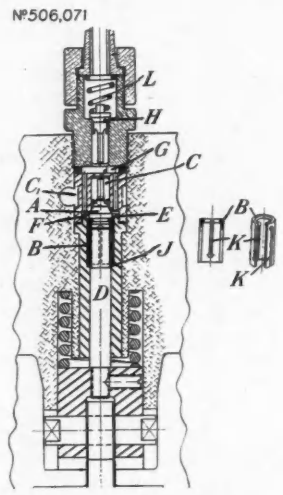


rotation of the shaft, so that the lubricant runs forcibly on to the surfaces to be lubricated. When the shaft becomes heated the ring D becomes heated to the same extent and expands without reducing the play of the bearing or interrupting the film of oil in the play space of the bearing or forcing it therefrom, because the ribs F readily and uniformly sag on the expansion of the ring and the accuracy of the mounting is maintained.—*May 19th*, 1939.

PUMPING AND BLOWING MACHINERY

506,071. October 21st, 1938.—RECIPROCATING PUMPS, William Young and Richard Martin Young, of Joseph Young and Sons, 65A, Haworth Street, Bolton.

According to this invention the suction valve of a pump is formed separately from the cylinder on the plunger or ram, but is attached so that it moves therewith. The inlet or suction valve A is formed separately from, but is attached to the end of the sliding cylinders B, the valve being formed with four transverse guide members which engage with the walls of a chamber C above the valve, and this chamber is in communication with an oil supply passage C_1 in the casing through radial passages. The upper part of the side walls of the chamber C are fluted and the guide members of A contact with the top of flutings leaving passages between through which the oil can pass. The valve A is thus guided in a vertical direction during the movement of the cylinder, and any tendency to sideways movement which might prevent immediate complete opening and closing of the valve is prevented. The cylinder B is formed with two series of longitudinal slots K, one series extending to the valve end of the cylinder and the other series to the opposite end. This construction ensures a good frictional contact between the plunger D and the inner walls of the cylinder, the slots at the same time serving for the communication between the

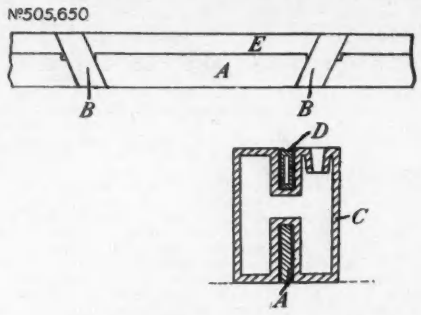


interior of the cylinder and the oil space E, which, when the valve is open, communicates with the oil supply in the casing F. The space E is also in communication with a space G below a spring-controlled discharge valve H by passages in the end of the casing F. The cylinder B is free to move in the casing F from the position when the valve A is in contact with its seating until the other end comes into contact with a stop or shoulder J on the casing. The operation of the pump is as follows:—When the plunger is at the beginning of the suction stroke, the valve A is closed and the oil supply is cut off. Immediately the plunger D commences its suction stroke its frictional contact with the inner surface of the cylinder B and the suction induced in the top of the latter causes the cylinder to move with the plunger until its movement is arrested by contact of its outer end with the shoulder J. This movement of the cylinder has moved the valve from its seating and consequently the interior of the cylinder behind the plunger is open to the oil supply passage through the passages and slots in the wall of the cylinder. Immediately at the beginning of the discharge stroke of the plunger, its movement first moves the cylinder B to close the valve A and the continued movement of the plunger forces the oil from the interior of the cylinder through the slots and passages to the underside of the spring L to allow the oil to be discharged.—*May 23rd*, 1939.

MISCELLANEOUS

505,650. August 11th, 1937.—JOINTS BETWEEN THE ABUTTING SECTIONS OF CONCRETE ROAD, Georg Wieland, Kronprinzenallee 321, Berlin-Zehlendorf, Germany.

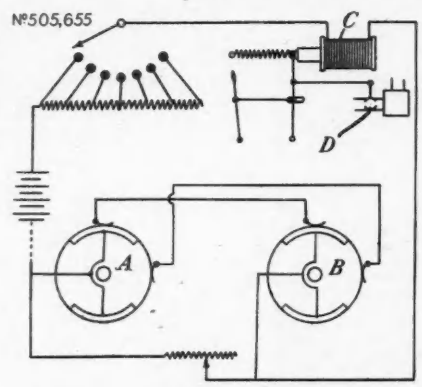
When connecting ends of adjacent pairs of concrete road sections or slabs by means of dowels consisting of iron pieces and the like in the abutting slabs, transversely to the joint, it is necessary for the dowels to be inserted whilst the slabs are still in the plastic form of freshly prepared concrete. As the concrete sets and hardens a contraction usually occurs, the slabs being frequently relatively displaced, and the final location of the dowels in the hardened slab can only be predicted with difficulty. According to the present invention, these drawbacks are obviated by providing corresponding grooves in adjacent slabs of concrete so that any two corresponding grooves in adjacent slabs together form a mortise for receiving a dowel after setting of the concrete. In an embodiment of the invention illustrated by way of example the road covering is cast in two superposed layers. Prior to casting a board A of about 13 cm. width is provided at the



desired point of joint between the adjacent surfaces of each pair of lower slabs. Each board has cut-outs in its upper surface corresponding to the mortises B, which cut-outs receive the mould box C and keep it in position. After placing the mould box in position the concrete mass for the lower layer is applied and allowed to set. A joint iron D is then inserted in the recesses of the aligned mould boxes. The concrete mass for the top layer E is then applied and allowed to set. After setting the mould boxes are removed from the concrete slabs. The board inset A is then cut away in the area of the mortise so as to leave a clear uniform space with inclined walls from the top to the bottom surface of each slab for the dowel, which is then inserted. The space moulded by the joint iron between the adjacent slab surfaces is preferably filled with bitumen.—*May 11th*, 1939.

505,655. October 13th, 1937.—SYNCHRONISING THE RUNNING OF ENGINES, Watson Hugh McNeile, of 25, Castle Street, Liverpool.

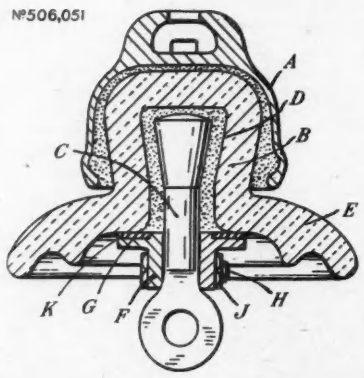
An arrangement is described in this specification for synchronising the speeds of two engines. Each engine drives a commutator A B with two segments interconnected through brushes and connected to a resistance in a solenoid circuit C. The throttle valve D of one engine is controlled by the flow of



current through the solenoid, so as to be capable of varying the engine speed between limits within which the speed of the second engine lies. A cyclic raising and lowering of the engine speed occurs in dependence on the relative positions of the two commutators, the disposition of the brushes and the size of the segments being such that when the commutators are in phase a maximum current flows through the solenoid.—*May 15th*, 1939.

506,051. November 16th, 1937.—ELECTRIC INSULATORS, Bullers, Ltd., and William George Robinson, both of 6, Laurence Pountney Hill, London E.C.4.

This invention concerns improvements in electric insulators of the kind having two metal attachments separated by the dielectric surface of the insulator and in which one of the metal attachments comprises a metal pin secured in and projecting from a socket in the insulator. The object of this invention is to prevent harmful corrosion of the pin when the insulator is used in D.C. systems. The insulator is a suspension unit having a metal cap A which surrounds the head B of the insulator and having a metal pin C cemented within a socket D in the insulator body. Although the leakage path between the pin C and the cap A is of considerable length, in view of the provision of the shed E, a certain degree of leakage is bound to take place,



particularly if the surface of the insulator becomes wet or dirty. The pin C is arranged on the positive side of the system and, should leakage take place, there is a tendency for the stem of the pin to be corroded. Clamped to the pin C is a two-part metal encircling member having two segmental sleeve portions F, each of which is provided with a flanged portion G. The two parts of the member are clamped together by two bolts H arranged one on either side of the pin and extending transversely thereof through holes in the two segmental parts F, which bolts are provided with clamping nuts J. A lead washer K is arranged between the insulator and the flanged portions G. With this arrangement, should any corrosion take place, it will occur on the flanged portions or lead washers, which may be readily removed and do not affect the strength of the pin.—*May 16th* 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Air Raid Protection Institute

Tuesday, July 11th.—Royal Society of Arts, John Street, Adelphi, W.C.2. "The History and Organisation of the Auxiliary Fire Service," A. L. Dixon. 8 p.m.

British Waterworks Association

Tuesday to Saturday, July 25th to 29th.—Summer meeting at Nottingham.

Institution of Civil Engineers

Saturday, July 15th.—MANCHESTER ASSOC.: Visit to Southport. 2.30 p.m.

International High Tension Conference

To-day and Saturday, July 7th and 8th.—Fondation Berthelot, 28 bis, rue Saint-Dominique, Paris.

Manchester Association of Engineers

Thursday, July 13th.—Visit to the soap, candle and starch works of Co-operative Wholesale Society, Ltd., Irlam. 2.30 p.m.

Royal Agricultural Society of England

To-day and Saturday, July 7th and 8th.—Annual Show in Windsor Great Park.

PERSONAL AND BUSINESS ANNOUNCEMENTS

J. GERBER AND CO., Ltd., have transferred their machinery trading business and workshops to the Wembley Exhibition Grounds.

HOUSEMAN AND THOMPSON, Ltd., manufacturers of D.M. boiler enamel, are removing to D.M. House, Jesmond Road, Newcastle-upon-Tyne, 2.

MR. JAMES BUSSEY, M.I. Struct. E., has been appointed a director of Thos. W. Ward, Ltd., Sheffield. Mr. C. A. Lee has been appointed a local director of the company.

MR. FRANK ASHCROFT MARTIN has been elected to the board of directors of Samuel Osborn and Co., Ltd., Sheffield. Mr. Martin joined the staff of the company in May, 1937, having previously been engaged from 1922 to 1937 on the technical staffs of the Associated Lead Manufacturers, Ltd., and other firms in the same trade.

MR. H. H. BERRESFORD has been appointed deputy managing director of the Staveley Coal and Iron Company, Ltd. Mr. Berresford has successively held the positions of cashier, registrar, assistant secretary, assistant general manager, and commercial manager, and was appointed a director in January, 1936. He is the chairman of the Foudry Pig Iron Producers' Association.

MR. R. W. GREGORY, M.I.E.E., A.I.H.V.E., consulting engineer, of Pilgrim House, Newcastle-on-Tyne, announces that from July 1st, 1939, he is taking into partnership Mr. Henry Edmeades Baker, B.A. Eng. (Oxford), A.M.I.E.E. The consulting engineers' business will continue at the above address under the existing firm name of R. W. Gregory and Partner. Mr. Baker has been on the staff of Messrs. Merz and McLellan and of McLellan and Partners.

CATALOGUES

RANSOMES, SIMS AND JEFFERIES, Ltd., Ipswich.—Catalogue of electric motors and dynamos.

J. PAYEN, Ltd., Church Street, Chiswick, W.4.—Descriptive price list of gaskets of all types and sizes.

HOLMAN BROTHERS, Ltd., Camborne.—Brochure illustrating and describing two-stage portable air compressors.

MORRIS AND INGRAM, 27, Finsbury Square, London, E.C.2.—Leaflets on the "Marvel" high-speed hack-saw blades.

WHITECROSS COMPANY, Ltd., Warrington.—Pocket catalogue of wire ropes for mining, shipping, and industrial purposes.

T. BALMFORTH AND CO., Ltd., Luton.—General catalogue of boilers, calorifiers, steam-jacketed pans, air receivers, stokers, &c.

EDISON SWAN ELECTRIC COMPANY, Ltd., 155, Charing Cross Road, London, W.C.2.—Descriptive price list of mercury and sodium lamps.

ROBERT BOBY, Ltd., Bury St. Edmunds.—Illustrated folder of materials handling machinery and steel and concrete constructional work.

E. H. JACK, Ltd., 11, Camden High Street, London, N.W.1.—Catalogue of British, American, and Continental ball and roller bearings in stock.

CATERPILLAR TRACTOR COMPANY, Ltd., Pretoria, Ill., U.S.A.—Catalogue describing the construction and uses of the D 7 oil-engined tractor.

GEORGE H. ALEXANDER MACHINERY, Ltd., 82–84, Coleshill Street, Birmingham.—Publication describing "Galex" high-speed milling cutters.

BABCOCK AND WILCOX, Ltd., Babcock House, Farringdon Street, London, E.C.4.—Booklet 1270 on the "B. & W." tube mill for pulverised fuel.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY, Ltd., 82, York Way, London, N.1.—Descriptive pamphlet of metal rectifiers for battery charging.

BUELL COMBUSTION COMPANY, Ltd., 49, Moorgate, London, E.C.2.—Booklet dealing with the elimination of the grit nuisance and the "Micro-Lector" dust separator.

DREWRY CAR COMPANY, Ltd., 10–11, Finsbury Circus, London, E.C.2.—Publications on oil and petrol locomotives and illustrating typical examples of railcars, power bogies, and locomotives.